PB-228 264

SELECTED URBAN STORM WATER RUNOFF ABSTRACTS. JULY 1970 - JUNE 1971

Franklin Institute Research Laboratories

Prepared for:

Environmental Protection Agency

July 1971

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PB 228 264

SELECTED URBAN STORM WATER
RUNOFF ABSTRACTS

JULY 1970 - June 1971

by

Science Information Services Department
The Franklin Institute Research Laboratories

Prepared for the
Environmental Protection Agency
Water Quality Research

Contract No. 14-12-904
Program Number 11024FJE
July 1971

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ABSTRACT

The July 1970 - June 1971 supplement to SELECTED URBAN STORM WATER RUNOFF ABSTRACTS is a compilation of abstracts summarizing articles from a variety of technical literature concerning the problem of urban drainage published from July 1970 through June 1971. The 234 abstracts covering a range of ten sections are arranged alphabetically by author and numerically by abstract number within each category. Each item includes a bibliographic citation, an abstract, and a set of indexing descriptors and identifiers. A subject index at the end of the volume provides the necessary access to individual concepts. An author index and a journal list are also included.

The first three quarterly issues fulfilled under Contract 14-12-904 were:

SELECTED URBAN STORM WATER RUNOFF ABSTRACTS (First Quarterly Issue): EPA Project No. 11024EJC 10/70
SELECTED URBAN STORM WATER RUNOFF ABSTRACTS (Second Quarterly Issue): EPA Project No. 11024EJC 01/71
SELECTED URBAN STORM WATER RUNOFF ABSTRACTS (Third Quarterly Issue): EPA Project No. 11024FJE 04/71.

This work was submitted in fulfillment of Contract 14-12-904 (EPA Project No. 11024FJE) between the Environmental Protection Agency, Water Quality Office and the Franklin Institute Research Laboratories.

FOREWORD

This edition of SELECTED URBAN STORM WATER RUNOFF ABSTRACTS is an integration of the first three previously published quarterly issues and abstract material summarizing articles from a variety of technical publications covering subjects pertinent to the problem of urban drainage.

The present work includes 234 abstracts of documents, 59 of which were compiled during the most recent quarter, published for the most part from July 1970 through June 1971. For convenience, the abstracts are classed in ten categories and arranged alphabetically by author and numerically by abstract number within each category. Since most of the papers fit into more than one category, a cumulative subject index at the end of the volume provides the necessary access to individual concepts and should be utilized for locating all abstracts in which this concept is significant. The numbers following an index term are the numbers for the abstracts in which this term is found. Each item includes a bibliographic citation, an abstract, and a set of indexing descriptors (subject terms listed in the WATER RESOURCES THESAURUS November 1966 edition) and identifiers (newly suggested index terms). The most important index terms are marked by an asterisk. An author index and a journal list are included for the reader's benefit.

Copies of the articles abstracted in most cases can be obtained from research libraries covering water pollution or public health engineering literature.

This work, submitted in fulfillment of Contract 14-12-904, was performed by the Science Information Services Department of the Franklin Institute Research Laboratories. Mrs. Dorothy Sandoski, acting as project leader, was responsible for the searching of literature for pertinent documents, abstracting and indexing, and overseeing the production of camera-ready copy of the report. Suggestions concerning the improvement of content and format, or expansion of subject coverage in future supplements will be gratefully received.

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SECTION 1.

Construction: Equipment and Materials; and Instrumentation

001
NEW EQUIPMENT--PRIMARY WATER TREATMENT AIDED BY COMPACT SEPARATOR,

Chemical Eng, Vol 77, No 15, pp 48 and 50, Jul 13, 1970. 1 diag.

Descriptors: *Pollution abatement, *Sewage treatment, *Equipment.
Identifiers: *Wastewater Concentrator, *Screen separator.

The Wastewater Concentrator takes up little space but has the capacity to screen sudden overloads of raw sewage (2,000-3,000 gpm) during rainfall. It provides standby primary treatment by screening influent and then collecting it in an annular chamber and directing it to a discharge box at the bottom of the unit. Materials not passed discharge through a 10-inch pipe. The workings, operating cycle, and advantages of the unit are described.

002
GRID FOR RETAINING LARGE COMPONENTS OF SEWAGE IN SEWAGE PUMPING EQUIPMENT,

Neth Patents +NL 6817241.

Descriptors: *Patents, *Sewage.
Identifiers: *Pumping equipment, *Retaining grid.

The grid is designed for insertion in a pipeline and for cleaning by backwashing. It is fabricated from a series of initially parallel plates bonded to the pipe wall at the edges. The dimensions are such that their axial length is at least 8 times the interplate spacing.

003
PREASSEMBLY METHOD SPEEDS STORM SEWER PROJECT,

Public Works, Vol 102, No 2, pp 85, Feb 1971.

Descriptors: *Urbanization, *Drainage systems, *Construction, Pipes, Bolts, Construction equipment.
Identifiers: *Storm sewers, *Preassembly, *Colorado Springs, Colorado.

As a result of rapid urban development in the City of Colorado Springs, improvements in its storm water drainage system are being undertaken. The Burks & Company, Inc. has recently completed the $480,000 construction of an elliptical storm sewer line which has a 13'11" bottom span with a center height of 8'7" and meets the H-20 loading standard requirements. The contractor opted to preassemble most of the line at street level, then used a brace of compact telescoping-boom hydraulic cranes to carry and emplace the sections. Between 85 and 90 percent of the bolting-up work was accomplished at street level and there were only two seams to bolt in the trench due to the fact that the pipe was assembled in bottom and top halves.

004

CATCHBASINS CLEANED FOR $3.00,

Public Works, Vol 101, No 8, p 81, Aug 1970. 2 fig.

Descriptors: *Cleaning, *Maintenance, Cost comparisons.
Identifiers: *Suction machine, *Teaneck, New Jersey.

Teaneck, New Jersey's switch from bucket cleaning of catchbasins to suction cleaning with a Good Roads Scavenger has reduced costs of the twice-a-year job by 80%. The rate of catchbasin cleaning has also increased considerably. The suction machine is also used to clean out manholes, to clean streets, and to pick up and dispose of leaves on streets and park grounds during autumn.

005

WASHED OUT ROAD REOPENED QUICKLY,

Public Works, Vol 101, No 8, p 84, Aug 1970. 3 fig.

Descriptors: *Construction, *Steel pipes, *Installation, *Construction materials.

This article describes how a concrete slab deck culvert, destroyed by a flash flood, was replaced in only eleven working days with two 90-inch corrugated galvanized steel pipes. The contractor laid the pipe employing all standard practices except for the special borrow gravel used for the entire fill. It is normally used only halfway up the pipe.

006
MINIATURE 'EYES' PROBE 170 MILES OF SEWERS,

Surveyor, Vol 127, No 4112, pp 34-35, Apr 1971. 4 fig.

Descriptors: *Sewers, *Inspection.
Identifiers: *Closed circuit television, *Great Britain.

The London Borough of Camden is using closed circuit television to undertake a comprehensive survey of their 170 mile sewer system. The cameras enter the system through manholes, and are cable winched through the sewer lines. Monitor vans allow inspection engineers to view and make videotape recordings of the sewers. For gulley connections and 10 cm house drains a 4 cm diameter Falcon camera is used. The use of closed circuit television allows visual inspection of inaccessible sewers.

007
PREASSEMBLING, CRANE EMPLACEMENT FOR MULTIPLATE STORM-SEWER LINE,

Water Sewage Works, Vol 118, No 2, pp 48-49, Feb 1971.

Descriptors: *Construction, *Construction equipment, *Materials, *Cranes, Labor mobility, Excavation, Safety, Specifications, Construction costs.
Identifiers: *Storm sewers, *Preassembly.

A 3100-foot section of large-diameter storm sewer in Colorado Springs, Colorado was constructed, based on preassembling most of the line at street level then using two telescoping-boom hydraulic cranes to carry and emplace the sections, by Burks & Company, Inc. for an estimated $480,000. Limited easements and tight working quarters made efficient handling with hydraulic cranes a key factor in determining the practicality of the multiplate material and the preassembly method. A 12.5-ton BLH Austin-Western with a 56-ft full power boom and a 15-ton Bantam wing crane unloaded trucks delivering 400 tons of steel, helped with assembly, and delivered and placed the assembled stations of the storm sewer line. Burk's project was part of the $2.8 million Little Shooks Run drainage basin improvements program. The contract called for installation of the multiplate storm sewer line and also covered excavation, backfilling and compaction, installation of catchbasins, and construction of new asphalt roadways replacing pavement destroyed by the trenching operations. Working with Warner-Swasey Hopto and Lorain backhoes to handle the major part of the excavation, the two crews, one starting in the middle and both working in the same direction, averaged about 52 feet/day of line put into place.

008

PRIME NEED: INSTRUMENTS FOR USE IN FIELD,

Rene J. Bender
Power, Vol 114, No 10, pp 50-53, Oct 1970.

Descriptors: *Water pollution control, *Instrumentation, *Monitoring, *Administration, Methodology.

As demand for pollution control has increased, so has the need for adequate instrumentation. Control of water pollution has reached a standard clearly ahead of air pollution control, and resolves itself into a matter of cost. Water management is becoming increasingly popular; monitoring instruments include pH meters, turbidity indicators, dissolved-solids recorders, DO, BOD, and COD meters, oxidation-reduction-potential sensors, and chloride-ion analyzers. The article contains recent developments in the following areas of methodology and instrumentation: the carbonaceous analyzer, atomic absorption, sewage treatment monitors, telemetry, and flow meters.

009

IDEAS ON THE CONSTRUCTION AND MANAGEMENT OF LARGE PUMPING STATIONS FOR SEWAGE,

Friedrich Wilhelm Burmeister
Staedtehyg, Vol 22, No 3, pp 57-66, Mar 1971. 17 fig, 3 graph, 6 ref.

Descriptors: *Treatment facilities, *Pumps, *Design, *Construction, Sewage, Design criteria, Storm runoff, Pipes, Pumping plants.

Pumping stations for sewage must be capable of handling large quantities of sewage as well as the sudden arrival of storm water. Suggestions are given for safe and economic designs of such pumps and their corresponding buildings. Instead of collection basins which are used in wastewater pumping stations, influx facilities with separate wastewater and rain water basins are used. For protection of rainwater pumps, rakes with prong intervals ranging from 40 to 80 mm depending on the dirt quantity are necessary. Automatic rakes with shredding equipment are only suitable for smaller plants. The total pumping capacity is divided into dry weather capacity and a rain and flood capacity. The pumping capacity in the dry weather section should include additional capacity for processing storm water and flood water. The capacity of the storm water pump should not be higher than twice the capacity of both dry weather pumps. Centrifugal pumps are preferred over piston pumps and all other pumps. Construction costs and building sizes are determined by the number and type of pumps used in each special case.

010
EVALUATION OF ASBESTOS-CEMENT PIPES IN EXTERNAL WATER SUPPLY AND SEWERAGE SYSTEMS,

Zygmunt Chabelski, Czeslawa Kotanska, and Wladyslaw Sawicki
Gaz, Woda Tech Sanit, Vol 45, No 3, pp 86-90, Mar 1971. 5 fig, 1 tab, 16 ref.

Descriptors: *Sewerage, *Water supply, *Construction, *Pipes.
Identifiers: *Asbestos-cement pipes.

Sections of water supply and sewerage systems in service were tested with regard to water and sewage inflow, and the condition of the ground in which the pipes were buried. Tests proved satisfactory for the use of asbestos-cement pipes.

011
GUNITE GIVES NEW LIFE ... to an old, falling brick sewer system,

William M. Englerth
Am City, Vol 85, No 7, pp 101-102, Jul 1970.

Descriptors: *Sewers, *Construction, *Gunite, Repairing, Costs.
Identifiers: *Chattanooga, Tennessee, Sewer lining, Capacity.

A visual inspection of the brick sewer system in Chattanooga, Tennessee resulted in its rehabilitation with pneumatically applied reinforced concrete lining, known as gunite. This repair method reduces the carrying capacity; however, the newly lined surface reduces many existing friction losses in the deteriorating conduit, and capacity in the repaired sewer is increased from the higher flow velocities. A total of $633,113.70 was needed to repair the main brick sewers in the downtown area of Chattanooga.

012
"BEEHIVES" PROTECT SNOW-REMOVAL SALT AND PREVENT WATER POLLUTION,

John R. Fitzpatrick
Am City, Vol 85, No 9, pp 81-83, Sep 1970.

Descriptors: *Control structures, *Structures, *Construction, *Structural design, Water pollution sources.
Identifiers: *Canada.

Salt-sand piles, used as storage for a road clearing mixture during winter months in Ontario and subject to leaching by rain, will be covered so as to lessen this potential source of contamination. This article discusses the construction materials, the design dimensions, and the methods of erection for the 20 sided, cone-shaped storage structure.

013
A GROWING MARKET FOR WATER AND WASTEWATER TREATMENT EQUIPMENT,

K. L. Kollar and William G. Youngwirth
Water Sewage Works, Vol 117, No 9, pp 319-325, Sep 1970. 7 tab, 2 chart, 8 ref.

Descriptors: *Treatment facilities, *Equipment, *Analysis, Evaluation, Construction equipment, Surveys.

This report summarizes and compares two studies (1965 and 1968) which are based on the response of manufacturers to a questionnaire on manufacturing plant production capacity and value of shipments of equipment used only in water and wastewater treatment plants. Both surveys accounted for about 95% and 70% of equipment sales to municipal water and wastewater treatment utilities and industrial water and wastewater treatment respectively. In 1968, $248.4 million was spent for water and wastewater treatment equipment by municipalities and industry with a 64+% increase in pollution control equipment. Tabled information includes: total expenditures, equipment shipments, structures, production capacities, and GNP comparisons. A list of equipment definitions is given.

014
PHOTOGRAPHY AND OTHER REMOTE SENSING OF WATER POLLUTION,

R. K. Lane
Water Pollution Control, Vol 108, No 9 ,pp 20-21, Sep 1970.

Descriptors: *Photography, *Data collections, *Remote sensing, Effluents, Pollutants.
Identifiers: Water pollution studies.

Photography has long been used as a remote sensing tool for environmental data collection from aircraft. In water pollution studies most interest is centered around the need for observing the behavior of effluents which introduce pollutants to rivers or lakes. Qualitative examinations of effluents through photography can be useful to locate effluents, to determine how their behavior is affected by local characteristics, ambient flow rates, and meteorological conditions, and to determine relative intensities of discharges. Techniques for quantitative assessments of polluted discharges are not yet operationally effective.

015
PRECAST, REINFORCED CONCRETE MEMBERS IN THE CONSTRUCTION OF WATER SUPPLY AND SEWERAGE SYSTEMS,

V. I. Lerner and I. S. Chumakov
Beton i Zhelezobeton, No 2, pp 8-10, Feb 1970.

Descriptors: *Construction materials, *Concrete construction, Sewerage.
Identifiers: *Water supply systems, *Sewerage systems, *USSR.

The construction of sewers and water supply tunnels made of large dimensional and relatively thin-walled reinforced concrete components has been experimented with by the Soviets. The methods of construction of reinforced concrete waterproof wall panels for rectangular and round vessels are discussed.

016
NEW AND OLD STORM DRAINS TEAM UP,

Alfred R. Pagan
Am City, Vol 86, No 4, p 112, Apr 1971. 2 fig.

Descriptors: *Sewers, *Storm drains, *Concrete pipes, *Construction materials, *Design.
Identifiers: *Pennsauken Township, New Jersey.

Pennsauken Township, New Jersey, built a storm drainage system across nearly-level terrain using 63x96-inch and 58x91-inch elliptical reinforced concrete pipes and 72-inch round pipes along with seven special chambers to connect the new pipes with existing lines. The use of old sewers in good condition provided a high quality drainage system at reasonable cost.

017
DRAIN CHANNEL PAVED WITH REINFORCED CONCRETE PIPE SECTIONS,

Alfred R. Pagan
Public Works, Vol 102, No 4, p 98, Apr 1971. 3 fig.

Descriptors: *Watersheds, *Drainage engineering, *Ditches, *Erosion control, *Pipelines, *Construction materials, *Design, *Installation, Joints (connections).
Identifiers: Gloucester County, New Jersey.

Water flow from another drainage basin was diverted into a ditch on Gloucester County, New Jersey - owned property, resulting in erosion problems. The ditch inverts were paved with one-half and one-third round pipe sections; this solved the erosion problems and is expected to eliminate almost all maintenance problems along the ditch.

018
DEVELOPMENT AND PERFORMANCE OF A MOBILE WATER QUALITY MONITOR,

Raymond W. Raible and M. K. Testerman
Advan Instr, Vol 24, Part 3, 1969. 3 fig, 6 ref, 5 p.
Presented at the Instrument Society of America 24th Annual
Conference, Oct 27-30, 1969.

Descriptors: *Instrumentation, *Control systems, *Monitoring.
Identifiers: *Data acquisitions.

A mobile water quality monitor intended for extended unattended use in locations where power lines are not available and for survey use is described. All solid state electronics are employed. Field tests have been performed for the past 2 years. Conclusions and problems concerning the monitors and transducers will be reviewed. Suggestions for future development are given.

019
THE NECESSITY OF IMPLEMENTING THE SECOND DRAIN AND SEWER TEST,

K. J. Saunders
J Inst Public Health Engrs, Vol 70, Part 2, pp 119-124, Apr 1970. 8 fig,
1 tab.

Descriptors: *Sewers, *Testing, *Failure (mechanics).
Identifiers: *Great Britain, *Water tightness.

The second drain and sewer test entails testing for water tightness in a sewer after laying, haunching, and backfilling are completed. This test is necessary in indicating any faults in the bedding or support of the pipe, inadequacies in design, or accidental damage done to the pipe as a result of backfilling. Calculations for this test are provided in the paper. Some causes of failure on the second test are: faulty workmanship, such as poor jointing; poor backfilling; excessive vertical loads, extra wide trenches, or inadeuqate bedding material, causing overload fractures; differences in settlement of a house and the ground causing shear fractures; stones used to level the pipes causing bearing fractures; and, high water tables.

020

THE MEASUREMENT OF THE EFFECTS OF BUILDING CONSTRUCTION ON DRAINAGE BASIN DYNAMICS,

D. E. Walling and K. J. Gregory
J Hydrol, Vol 11, No 2, pp 129-144, Aug 1970. 8 fig, 21 ref.

Descriptors: *Construction, *Urbanization, *Investigations, *Sediment yield, *Storm runoff, *Rainfall-runoff relationships, Hydrograph analysis, Soil erosion, Peak discharge.
Identifiers: Urban hydrology, Great Britain.

The magnitude of the impact of building activity upon suspended sediment concentrations may be assessed by comparing samples obtained simultaneously at different points within one catchment or comparing samples derived from two adjacent small watersheds, one of which serves as a control. In each case the suspended sediment concentrations are between 2 and 10 times, and occasionally up to 100 times, greater than the concentrations obtained from undisturbed conditions. The form of the relationships obtained demonstrates the importance of variable source areas within the catchments. To assess the yields over time, streamflow and sediment records are required. A small catchment has been instrumented for this purpose on the margin of Exeter, Devon, England. The catchment was calibrated for a period of 17 months prior to building activity by deriving multiple regression equations relating peak flow, runoff amount, and runoff percentage to precipitation characteristics at different times of the year, by evaluating unit hydrographs, by establishing suspended sediment rating curves, and by using two adjacent catchments as controls.

SECTION 2.

Overflows and Regulation Devices

021
PRIMARY WATER TREATMENT AIDED BY COMPACT SEPARATOR,
Sweco, Inc.

Chem Eng, Vol 77, No 15, pp 48,50, Jul 13, 1970. 1 fig.

Descriptors: *Sewage treatment, *Waste water treatment, *Sewage, *Storm runoff, Pollution abatement.
Identifiers: *Wastewater concentrator.

A new kind of primary wastewater treatment has been introduced to help pollution abatement specialists solve two of their most recurrent headaches: inadequate acreage for large enough settling basins, and excessive wastewater loads resulting from heavy rainfalls. The wastewater concentrator, as this unit is called, was designed primarily for municipal sewage treatment.

022
AUTOMATIC SEWAGE REGULATOR ANNOUNCED,

Delaware Valley Ind, Vol 44, No 1, pp 27, Jan 1971.

Descriptors: *Regulated flow, *Automatic control, *Separation techniques, *Storm runoff.
Identifiers: *Sewage flow regulator, Combined sewers.

A new, automatic sewage flow regulator, developed by Neyrpic Incorporated and installed in a collector, provides for accurate flow control to the interceptor shutting off automatically all flow to the interceptor when the collector flow decreases below this preset value, the regulator opens automatically and water flows again to the interceptor thus insuring reliable and foolproof separation of sanitary flows (diverted to treatment stations) and storm waters (discharged away).

023
FINE-MESH MECHANICAL SCREEN CONCENTRATES PEAK WASTE LOADS,

Filtration Eng, Vol 1, No 10, pp 8-10, Jun 1970. 2 fig.

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Descriptors: *Wastewater treatment, *Pollution abatement, *Overflow, *Sewers, Storm runoff, Equipment.
Identifiers: *Wastewater concentrator.

A new product known as the wastewater concentrator uses a mechanical screening principle to reduce pollution caused by the overflow from combined storm and sanitary sewage systems during periods of heavy rainfall. In storm overflow service, the concentrator can augment a treatment process via high-rate, fine mesh centrifugal screening which relieves the existing system of its hydraulic overload. It was demonstrated that the concentrator is capable of removing 99 percent of the floatable and settleable solids, 34 percent of the suspended solids, and 27 percent of the COD from sanitary waste. A description of the operation, apparatus, and maintenance involved in the concentrator's performance is given.

024
WASTEWATER VOLUME TO BE MEASURED ULTRASONICALLY,

Instrumentation Technol, Vol 18, No 5, pp 14, 25, May 1971.

Descriptors: *Measurement, *Sewerage, *Treatment facilities, *Ultrasonics, Flowmeters, Instrumentation.
Identifiers: *Milwaukee, Wisconsin.

The City of Milwaukee, Wisconsin is metering the volume of wastewater entering its treatment plants with an ultrasonic flow meter and an ultrasonic level instrument of the air sonar type for each sewer, and electronic gear for processing the signals from each meter and level instrument. This system has been shown to give greater accuracy at less maintenance and repair costs than other methods.

025
TECHNOLOGY: TEST COMBINED SEWER TREATMENT,

Modern Power Eng, Vol 64, No 8, p 33, Aug 1970.

Descriptors: *Sewers, *Sewage treatment, *Treatment facilities, Overflow.
Identifiers: *Combined sewers, *Storm sewers, *Storm overflows, Racine, Wisconsin.

Racine, Wisconsin is the test area for a system of satellite sewage treatment plants designed to eliminate the need for separating storm and sanitary sewers. The process involves five satellite plants which will treat the discharge from the combined sewer overflow during periods of heavy runoff. A screen/dissolved air flotation unit will remove inorganic pollutants and suspended solids from the combined sewer overflow.

026
COMBINED SEWER TEMPORARY UNDERWATER STORAGE FACILITY,
Melpar, An American-Standard Company, Falls Church, Virginia

FWQA Contract No 14-12-133, Program No 11022DPP, Oct 1970. 61 p, 16 fig, 12 tab, 2 ref, append.

Descriptors: *Pilot plants, *Underwater, *Storage, *Overflow, Laboratory tests, Costs, Investigations.
Identifiers: *Storage facilities, *Combined sewers, *Choptank River, *Cambridge, Maryland.

A pilot plant underwater storage facility was designed, constructed, operated, and evaluated as a method of temporarily storing storm overflow from the combined sewer of the Choptank Avenue drainage basin, Cambridge, Maryland. Combined sewage in excess of the sewer capacity, which would normally be discharged directly into the Choptank River, was intercepted and pumped into a normal 200,000 gallon flexible underwater storage container located 1300 feet offshore. The stored overflow was later returned from the tank at a rate which could be accommodated by the intercepting sewer and treatment plant. The facility was tested with overflow both from four naturally occurring rainfalls and using fresh water simulation. The overflow samples were analyzed in a field laboratory for the following characteristics: pH, suspended solids, volatile suspended solids, settleable solids, 5-day biochemical oxygen demand, and chemical oxygen demand. The pilot plant facility was capable of collecting 96% of the average annual overflow from the drainage basin at a cost of less than $1.85 per thousand gallons. The facility could prevent the annual discharge of 7,136 pounds BOD into the Choptank River. Underwater storage facilities could be used effectively for a number of combined sewer areas. Site selection, however, has been proven to be a critical factor. Care must be exercised to prevent public disturbance, and factors such as land use, tidal conditions, or the types of storms must also be considered.

027
MICROSTRAINING AND DISINFECTION OF COMBINED SEWER OVERFLOWS,
Cochrane Division, Crane Company, King of Prussia, Pennsylvania

FWQA Contract No 14-12-136, Program No 11023EVO, Jun 1970. 76 p, 16 fig, 7 tab, 12 ref.

Descriptors: *Sewers, *Storm runoff, *Filtration, *Water pollution control, *Cost comparisons, Water quality, Ozone, Chlorine, Biochemical oxygen demand.
Identifiers: *Microstraining, *Combined sewer overflow, *Suspended solids removal.

A microstrainer screen of a nominal aperture of 23 microns was used to remove up to 98% of the suspended solids from a combined sewer overflow. The sewer in a residential area of Philadelphia has an average dwf of 1,000 gph. The maximum combined sewer flow during rainstorms in one year of operation was 304,000 gph. Volatile suspended solids removals with the above screen have averaged 68% and 71% during different test periods. Results indicated that there was a slightly better kill of coliform group bacteria with chlorine than with ozone in the microstrainer effluents when both were used at an initial nominal concentration of 5 ppm, with 5 to 12 minutes detention time. Chlorine was applied at slightly higher levels and with better control than ozone. Preliminary estimates of the costs of treatment via this process, using tentatively-established throughput rates, show that the capital costs per acre of drainage would be approximately $10,200 for microstraining alone, $11,200 for microstraining plus chlorination, and $19,800 for microstraining plus ozonation. Of eight other currently-proposed schemes, whose costs were estimated, only surface impoundment appears competitive.

028

IN-SEWER FIXED SCREENING OF COMBINED SEWER OVERFLOWS,
Envirogenics Company, El Monte, California

EPA/WQO Contract No 14-12-180, Program No 11024FKJ, Oct 1970. 144 p, 21 fig, 11 tab, 2 ref, 9 append.

Descriptors: *Sampling, *Laboratory tests, *Sewers, *Sewerage, Storm runoff, Waste water treatment, Sewage treatment, Correlation analysis.
Identifiers: *Combined sewers, *Sewer overflows, *Fixed screens, *Solids removal.

A field sampling and analysis program, supplemented with laboratory studies, was conducted to characterize combined sewage contributions to combined sewer overflows, ascertain the removal of floatables and solid materials that could be effected by the placement of screening devices in combined sewer systems, and assess the effect of solids removal on chlorination requirements and bacterial concentrations. Statistics are presented on combined sewage bulk and screenings collected with 0.125-, 0.25-, 0.5-, and 1.0-in. aperture screens.

Statistically significant correlations at the 95-% confidence level were obtained for the combined sewage bulk only between total solids and total volatile solids, between total volatile solids and total volatile suspended solids, and between total suspended solids and total volatile suspended solids. For combined sewage screenings, statistically significant correlations at the 95-% confidence level were found between total solids and total volatile solids, between BOD and COD, between BOD and hexane extractable material, and between COD and hexane extractable material. Removals of total solids, total folatile solids, biochemical oxygen demand, chemical oxygen demand, hexane extractable material, total coliforms, fecal coliforms, and fecal streptococci resulting from placement of the screening devices into the combined sewer were marginal. Fixed screening of combined sewage with aperture sizes ranging from 0.0164 to 1.0 in. appear to have little effect on total coliform and fecal coliform densities or bacterial kills by chlorination with chlorination requirements being reduced only slightly.

029

RETENTION BASIN CONTROL OF COMBINED SEWER OVERFLOWS,
Springfield Sanitary District, Springfield, Illinois

EPA/WQO Grant No 3-111-1, Program No 11023---, Aug 1970. 97 p, 37 fig, 4 tab, 8 ref, 4 append.

Descriptors: *Sewers, *Overflow, *Retention, *Groundwater basins, *Control, Algae, Fishkill, Biochemical oxygen demand, Coliforms, Sludge, Design.
Identifiers: *Combined sewers, *Urban drainage, Pollution sensitive organisms.

Control of combined sewer overflows by retention in an open basin has been evaluated. Fish kills, which were numerous prior to construction of the facility, ceased and there was an increase in the abundance of pollution sensitive organisms in the stream below the basin. Average annual reduction of BOD was 27% and coliform reduction averaged 72%. However, during the period from June through Oct. 1969, production of algae in the basin caused the effluent BOD to exceed consistently that of the influent. In addition to the oxygen demand on the stream, production of algae may be objectionable at some installations for aesthetic reasons. Sludge accumulation was significant in the basin and must be taken into account in design of similar facilities. Suggestions for future designs of retention basins are included.

030
ROTARY VIBRATORY FINE SCREENING OF COMBINED SEWER OVERFLOWS;
Primary Treatment of Storm Water Overflow from Combined Sewers by High-Rate, Fine-Mesh Screens,
Cornell, Howland, Hayes and Merryfield Consulting Engineers and Planners

Federal Water Pollution Control Admin., Publication No DAST-5, Mar 1970. 6 tab, 18 fig, 3 append, 4 modifications.

Descriptors: *Investigations, *Screens, Overflow, Separation techniques, Waste water treatment.
Identifiers: *Storm overflows, *Rotary screens, Treatment method, Combined sewers.

The objective of this study was to determine the feasibility, effectiveness, and economics of employing high-rate, fine-mesh screening for primary treatment of storm water overflow from combined sewer systems. The final form of the screening unit stands 63 inches high and has an outside diameter of 80 inches. The unit is fed by an 8-inch pipe carrying 1700 gpm which is distributed to a 60-inch diameter rotating stainless steel collar screen having 14 square feet of available screen area and a 165 mesh. The screen is backwashed at the rate of 0.235 gallons of backwash water per 1000 gallons of applied sewage. The unit is capable of 99% removal of floatable and settleable solids, 34% removal of total suspended solids, and 27% removal of COD. The screened effluent is typically 92% of the influent flow. The estimated cost of treatment is 22¢/1,000 gal on the basis of a scale-up design.

031
CHARACTERIZATION AND TREATMENT OF COMBINED SEWER OVERFLOWS,
Engineering-Science, Inc., Arcadia, California

City and County of San Francisco, Calif, Nov 1967. 202 p, 59 fig, 24 tab, 21 ref. FWPA Grant WPD-112-01-66.

Descriptors: *Pollution abatement, *Discharge, *Overflow, *Water pollution, *Sewage effluents, Flotation, Chlorination, Aeration, Sewerage.
Identifiers: *Combined sewers, San Francisco, California, San Francisco Bay.

This publication is the final report of a study made by the City and County of San Francisco to develop workable systems to manage overflows from the combined sewers of San Francisco. The ultimate objective is to alleviate pollution of the Bay and the Pacific Ocean caused by sewer overflows. The Selby Street sewer system and the Laguna Street system were used as study sites. Storm overflows were monitored for quantity and quality characteristics. Rain gage measurements were also recorded. A coliform survey of the municipal marina was made, and laboratory tests were conducted to select suitable methods for treating combined sewer overflows. The project findings were: 1) concentrations of various constituents in the overflows follow a distinct pattern; 2) the delay time is constant; 3) separation in sewers would not result in any significant reduction in the pollution of receiving waters; 4) coliform levels in receiving waters are significantly affected by wet weather discharges; and, 5) treatment of the combined sewer overflows, using the dissolved air flotation process in conjunction with chlorination, appears to be the most feasible solution.

032
PROPOSED COMBINED SEWER CONTROL BY ELECTRODE POTENTIAL,
Merrimack College, North Andover, Massachusetts

FWQA Contract No 217-01-68, Program No 11024DOK, Feb 1970.
69 p, 20 fig, 10 tab, 38 ref.

Descriptors: *Pollution abatement, *Laboratory tests,
*Measurement, *Sewage disposal, *Investigations, *Overflow.
Identifiers: *Discharge modulation, *Electrode potential.

The objective of the report was to investigate the effectiveness of electrode potential measurements to modulate discharge from combined and storm sewer overflows thus reducing stream and estuarine pollution. The analysis of experimental results, using predominantly stale, domestic sewage in the laboratory, shows a high degree of correlation between the electrode potential of the sewage and its strength. The 3/8-inch diameter Ag, AgCl-Pt flow through cells, showing no polarization during the ten months of sewage experimentation, were found to yield the most stable, reproducible, and accurate readings. Based on these limited investigations it appears that the addition of a buffer to sewage may be helpful in stabilizing the potential, although the influence of a strong reductant may be masked. It was demonstrated that the potential will be more negative the greater the S= concentration, except when a small amount of DO is present which exerts an attenuating influence.

033
COMPUTER CONTROL OF COMBINED SEWERS,

James J. Anderson
Saint Paul, Minneapolis; Watermation, Inc, Oct 1969. 19 p, 26 fig, 8 tab, 22 ref.

Descriptors: *Automatic control, *Computers, *Regulated flow, *Control systems, *Pollution abatement, *Surface runoff, *Flow control, Sewers.
Identifiers: *Combined sewers, *Minneapolis - Saint Paul Sanitary District, *Urban runoff.

This paper describes a unique application of digital computers for maximizing the capture of urban runoff in the combined sewer system of the Minneapolis - St. Paul Sanitary District. The real-time dynamic computer control of system overflow-regulators proved effective in helping to increase flows in interceptor sewers, thus reducing the frequency of overflows of raw sewage to the Mississippi River. Major overflow regulators were modified by replacing floats on the gates with hydraulic cylinders. Inflatable dams were installed in trunk sewer outlets. Level-sensing bubbler tubes with transducers and gate position slidewires were installed to provide sewer level and regulator status information. Control and telemetry equipment were installed in underground vaults. The data acquisition and control system provides both manual-remote and automatic control of the system by central computer using leased telephone wires. The author describes the river monitoring and wastewater sampling methods employed, the rain gage installations, mathematical modeling, and operating methods. He concludes that the feasibility of controlling and operating a large combined sewer system, using centralized computer control, has been demonstrated and that this data acquisition system will facilitate future testing of improvements in water resource management.

034

DISPATCHING SYSTEM FOR CONTROL OF COMBINED SEWER LOSSES,

James J. Anderson
An Interim Report to the Federal Water Pollution Control Administration, Minneapolis, Minn, May 1969. 115 p, 76 fig, 20 tab.

Descriptors: *Flow control, *Control systems, *Pollution abatement, *Remote control, Surface runoff, Sewers, Urbanization, Monitoring, Minnesota.
Identifiers: *Combined sewers, *Overflow regulators.

The report describes a $1,741,000 demonstration project initiated as part of a national program designed to find alternatives to the costly method of sewer separation for reducing pollution of receiving waters from overflows of combined sewers. Key combined sewer regulators in the Minneapolis-St. Paul sewer system were modified. A system for remote control of these regulators and a system for monitoring liquid levels in major sewers are operational, using a small process control computer and leased telephone lines. Remote reading rain gages were connected to the system to permit using a mathematical model in the computer to predict storm flows in the interceptors and to guide operation of the regulators.

Significant reduction of pollution in the Mississippi River from overflows are attributed to: manual-remote monitoring of sewer levels, regulator modifications, and improved regulator maintenance. The program has demonstrated that overflow regulators can be remotely controlled using a computer-based telemetry system.

035
A RE-EXAMINATION OF THE STORM TANK PROBLEM,

L. B. Escritt
Water Waste Treat J, Vol 12, pp 298-300, 1969.

Descriptors: *Storage, *Treatment, Storms, Sewerage.
Identifiers: *Storm sewage, *Storm tanks, Combined sewers.

The author discusses current practices and recommendations concerning the storage and treatment of storm sewage from combined or partially separated sewerage systems, and suggests that tanks of large capacity should be installed to provide adequate storage for all storm periods. Spillage volumes from storm sewage tanks of various detention periods are tabulated for storms of various durations assuming full treatment of 6 times the dry-weather flow and an average impermeable area for a combined sewerage system.

036
COMBINED SEWER REGULATION WITH FLUIDIC REGULATORS,

Peter A. Freeman
J Water Pollution Control Fed, Vol 43, No 4, pp 862-871, May 1971. 11 fig, 1 graph, 3 ref.

Descriptors: *Sewers, *Regulation, Irrigation design, Overflow.
Identifiers: *Fluidic regulators, *Philadelphia, Pennsylvania, *Akron, Ohio, Combined sewers.

Details of the fluidic combined sewer regulator are provided. This concept will be demonstrated at two locations in Philadelphia, Pa., and at one location in Akron, Ohio; testing at these units should begin in the spring of 1971. The fluidic combined sewer regulator concept, as developed under a WQO research program, seems to hold considerable promise for greatly reducing the pollution of the nation's receiving waters from combined sewer overflows. The units are simple, low in cost, and operate without moving mechanical parts. In addition to these beneficial characteristics, they offer the much improved regulation performance obtainable with current float-operated units or the large electromechanical, or electrohydraulic units. Fluidic sewer regulators can readily be installed in existing facilities at modest cost and offer the operational reliability and minimum maintenance and surveillance costs of static diversion structures.

037
THE FUTURE TASKS OF WASTEWATER DRAINAGE IN MUNICH,

Franz Karnovsky
Gas- Wasserfach (Wasser/Abwasser), Vol 112, No 3, pp 132-136, Mar 1971.
4 fig, 2 tab, 1 ref.

Descriptors: *Sewerage, *Sewers, *Treatment facilities, Construction costs, Future planning.
Identifiers: *Germany, *Storm overflows.

Munich's sewer system is considerably overloaded thus making its expansion imperative. Yet damage has not occurred due to the numerous rain overflows which empty into the river Isar and other smaller waterways. A new main sewer must be built, and rain overflows abandoned. This main sewer is designed for draining off 50 cu m/sec. Connection sewers and purification plants are also required. The task of extending the sewer system is expected to last until the year 2006. Construction of the purification plant Grosslappen, with a capacity of 7.5 cu m/sec, is scheduled for completion in 1972. A second purification plant to be erected in accordance with the master plan will have a capacity of 9.0 cu m/sec.

038
STORM-WATER RETENTION CAN WORK...and Prevent the Heavily Polluted "First Flush" from Overflowing to Damage the Receiving River,

Gerald Remus
Am City, Vol 85, No 10, pp 68-69, Oct 1970. 2 fig.

Descriptors: *Storm runoff, *Sewers, *Monitoring, *Control systems, Sewerage, Data collections.
Identifiers: *Detroit, Michigan, *Overflow abatement.

An intense thunderstorm over Detroit, Michigan dropped about one billion gallons of water with about 450 million gallons entering the sewer system that processed 365 million gallons in excess of average flow during the following 30 hours. The system retained so much storm water that the overflow outfalls, which normally discharge into the Detroit and Route Rivers, had very little to do. The sewer monitoring and remote control system, briefly discussed, efficiently compiled rainfall and sewer-level data every five minutes.

039
CAN POLYMERS HELP YOUR COLLECTION SYSTEMS?,

I. W. Santry
Water Wastes Eng, Vol 7, No 11, pp 47-48, Oct 1970. 2 fig, 1 ref.

Descriptors: *Overflow, Sewers, Flow rate, Peak loads.
Identifiers: *Polymers, Capacity.

The use of polymers, formed by chain grouping of similar organic molecules being cationic, anionic, or nonionic, reduce fluid flow friction resulting in an increased velocity in a sewer during application for varying distances downstream. What happens in the system is that the long chains of high molecular organic material dampen the eddy viscosity conditions making greater use of streamlining and the extension of the laminar boundary layer into the turbulent flow region. At present polymers appear to be limited to short time uses that occur because of peak flows and other emergencies.

040
STORM WATER/SEWAGE CONTROL,

Walter J. Talley
Effluent Water Treat J, Vol 10, No 10, pp 592-595, Oct 1970. 3 fig, 4 ref.

Descriptors: *Screens, Equipment.
Identifiers: *Combined sewers, *Storm overflows, *Wastewater concentrator.

The combined sewer overflow problems affect approximately 36 million people in England and Wales, and 51 million people in the United States. Over a year's period, estimates on the percent of liquid sanitary sewage that overflows with the storm overflow in combined sewer systems vary from 2% to 10%. High-rate, fine-mesh screens and the wastewater concentrator, which are the products of research basically directed at finding means for storage and treatment of storm/sanitary overflows, are discussed briefly.

SECTION 3.

Sewer Hydraulics

041

SURFACE WATER DRAINAGE,

L. Brassill
J Inst Munic Engrs (London), Vol 97, pp 303-310, Nov 1970. 4 fig, 4 tab.

Descriptors: *Design, *Methodology, *Sewers , *Storm runoff, Drainage Rainfall, Runoff.
Identifiers: *Storm sewers, Design research.

In this paper the design concept of sewers generally and storm sewers in particular is discussed and a review is presented of established practice and more recent research relating to this design aspect. All sewer design methods consist of the following four operations, fully detailed herein: frequency of flooding, design rate of rainfall, calculation of the rate of runoff from the rate of rainfall, and calculation of the sewer size. The author copies explore the procedure, shortcomings, and accuracy comparisons of earlier design methods, such as the rational method, the tangent method, the Coleman and Johnson system, and the Ormsby and Hart method, and more recent methods, such as the unit hydrograph method and the Road Research Laboratory Hydrograph method. It is concluded that: in schemes where sewer size larger than 24 inches are likely to be encountered the RRL hydrograph approach is the most satisfactory, otherwise the rational method gives satisfactory results; the Colebrook-White formula should be used for the solution of all hydraulic data associated with the design; and exploration concerning storm water drainage appears to have been adequately investigated for all normal design purposes.

042

OPTIMIZING THE DESIGN OF URBAN WASTEWATER COLLECTION SYSTEMS,

LaVere Barrus Merritt
Ph.D. Thesis, University of Washington, 1970.

Descriptors: *Sewerage, *Design, *Optimization, *Mannings Equation, Costs, Sewers.

This study is primarily concerned with the hydraulic functional design of sewer systems, and emphasizes the following ideas: (1) determination of optimal design, and (2) sensitivity of system costs to change in the design constraints. A cost sensitivity analysis was made of two typical, existing collection systems. The results of these analyses indicate

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that rather large cost variations are associated with changes in the binding constraints. Total sewer system cost savings of at least 10 percent are possible when this optimizing design program is employed.

043

EFFECT OF RAIN COLLECTING BASINS ON THE YEARLY INFLUX OF POLLUTANTS INTO A SEWER MAIN: FUNDAMENTALS OF DIMENSIONING COLLECTING BASINS,

Walter Munz
Gas-Wasserfach (Wasser/Abwasser), Vol 109, No 30, PP 823-827,
Jul 26, 1968. 4 fig, 1 tab, 8 ref.

Descriptors: *Sewers, *Infiltration, *Water pollution sources, Mathematical studies.
Identifiers: *Collecting basins.

The International Water Protection Commission for Lake Constance was faced with the question of the magnitude of the effect of an individual measure on the yearly influx of pollutants into the sewer main. To provide an answer, the author worked out a procedure for computations of material flows for different combinations of measures of differing effectiveness under given conditions. Such computations were carried out at the Zurich Technical University and the Baden-Wurttemberg Hydrological Administration. The results of the computations relating to the elimination of BOD by various combinations of pertinent measures are presented in graphs and briefly discussed. The author also presents a systematic classification of all possible kinds of rain collecting basins according to basin type and the relative altitude of the basin outlet with respect to its inlet.

044

REAL TIME ROUTING OF FLOOD HYDROGRAPHS IN STORM SEWERS,

Shih-Tun Su (discussion)
J Hydraulics Div, Am Soc Civil Engrs, Vol 97, No HY3, pp 464-465,
Mar 1971.

Original Paper: REAL TIME ROUTING OF FLOOD HYDROGRAPHS IN STORM SEWERS,
Garth S. Harris
J Hydraulics Div, Am Soc Civil Engrs, Vol 96,
No HY6, pp 1247-1260, Jun 1970.

Descriptors: *Flood routing, Storm runoff, Hydrographs.
Identifiers: *Average-lag method, *Discussion.

Su contends that the accuracy and reliability lost by using the simplified flood routing methods should be considered in the application of such a method. A detailed listing of all the limitations under which the progressive average lag method can be applied is advocated. A more precise measuring system or mathematical description for the three inflow hydrographs used by the author is deemed necessary to distinguish one from the other. Citing examples from the author's text, Su further contends the necessity to study other simplified routing methods in which the coefficients or parameters relate closely to the physical picture.

045
REAL TIME ROUTING OF FLOOD HYDROGRAPHS IN STORM SEWERS,

Ben Chie Yen (discussion)
J Hydraulics Div, Am Soc Civil Engrs, Vol 97, No HY2, pp 368-369, Feb 1971. 2 ref.

Original Paper: REAL TIME ROUTING OF FLOOD HYDROGRAPHS IN STORM SEWERS,
Garth S. Harris
J Hydraulics Div, Am Soc Civil Engrs, Vol 96,
No HY6, pp 1247-1260, Jun 1970.

Descriptors: *Flood routing, Storm runoff, Hydrographs, Open channel flow, Flow.
Identifiers: Storm sewers, Discussion.

For flow having mixed supercritical and subcritical modes with a critical section or a hydraulic jump occurring within the reach of the sewer, Yen contends that not only the critical section or the hydraulic jump is usually moving but also the discontinuity must occur along the characteristics thus making the method of characteristics for routing open channel flow quite complicated. Furthermore, Yen holds that the accuracy of the results obtained by using equations 19 through 22 is questionable due to the fact that sewers often do not have such a long length as in long channels with negligible backwater effect.

046
FLOOD ROUTING THROUGH STORM DRAINS: PART I--SOLUTION OF PROBLEMS OF UNSTEADY FREE SURFACE FLOW IN STORM DRAINS,

V. Yevjevich and A. H. Barnes
Colorado State University Hydrology Paper No 43, Nov 1970. 107 p, 44 fig, 36 tab, 23 ref, 5 append.

Descriptors: *Routing, *Flood routing, *Storm drains, *Unsteady flow, Mathematical models, Computer programs, Hydraulic models, Waves (water), Critical flow, Supercritical flow, Discharge (water), Flow, Runoff, Storm runoff.

Flood routing through storm drains was studied in a 3-ft diameter, 822-ft long storm conduit and theoretically in terms of the unsteady free-surface flow. Numerical integrations of differential equations by the specified interval scheme, the diffusing scheme, and the Lax-Wendroff scheme are discussed. The method of characteristics is selected for the practical integration procedure whenever the complete differential equations are used. Experimental and analytical investigations of the geometric and hydraulic parameters that define the coefficients of the two differential equations are summarized. The initial and boundary conditions are expressed mathematically for the numerical solutions. The analytically computed waves are then compared with the experimentally observed waves by using the same initial and boundary conditions. Qualitative and quantitative comparisons are given for depth hydrographs at different positions, for depth wave profiles at different instants in time, and for the peak-depth versus both position and time. From a practical point of view, good agreement is indicated by these comparisons. The errors in conduit geometric parameters, in hydraulic parameters, in numerical computations, and in experimental observations are analyzed and discussed.

047

FLOOD ROUTING THROUGH STORM DRAINS: PART II--PHYSICAL FACILITIES AND EXPERIMENTS,

V. Yevjevich and A. H. Barnes
Colorado State University Hydrology Paper No 44, Nov 1970. 43 p, 49 fig, 13 tab, 13 ref.

Descriptors: *Flood routing, *Storm drains, *Hydraulic models, *Colorado, Routing, Unsteady flow, Laboratory tests, Waves (water), Instrumentation, Calibrations, Computer programs.

Experimental storm drain routing research facilities and experiments are described. Design and construction of the experimental storm drain system, instrumentation and calibration, the data recording system, various experimental test conditions and their typical results, and experimental errors are discussed. A large conduit, 3 feet in diameter and 822 feet long, was constructed to accurately measure geometric and hydraulic characteristics, and the propagating of flood waves. The calibration of the instruments has been carried out to the point where there are relatively small errors. The data recording system was designed and constructed so that the output could be put either on cards or paper tapes and provide a direct input for computations on a digital computer.

048

FLOOD ROUTING THROUGH STORM DRAINS: PART III--EVALUATION OF GEOMETRIC AND HYDRAULIC PARAMETERS,

V. Yevjevich and A. H. Barnes
Colorado State University Hydrology Paper No 45, Nov 1970. 37 p, 24 fig, 12 tab, 10 ref.

Descriptors: *Flood routing, *Storm drains, *Hydraulic models, Hydraulics, Unsteady flow, Non-uniform flow, Channel morphology, Flow resistance, Hydraulic design, Shear drag, Roughness (hydraulic).

Results are given of investigation of the geometric and hydraulic parameters of an experimental storm drain routing facility. The errors in cross section geometric parameters are analyzed in a conduit not ideally circular but approximated by an elliptical shape; errors are also analyzed when the undulations in the longitudinal slope of the conduit affect the predicted water surface profiles and thus the geometric parameters for a given water depth. The variation of hydraulic parameter of resistance, expressed by the Darcy-Weisbach friction factor, is experimentally determined and compared to the theoretical relation to Reynolds number. Energy losses in a 90 degree junction box are studied. The velocity distribution coefficients are shown to vary with the Darcy-Weisbach friction factor, and consequently, with the depth of flow. Boundary conditions for both controlled and free outfall are experimentally determined and approximated by power functions. Two types of steady non-uniform flow profiles were observed and analyzed as the initial conditions for the unsteady flow computations.

049

FLOOD ROUTING THROUGH STORM DRAINS: PART IV--NUMERICAL COMPUTER METHODS OF SOLUTION,

V. Yevjevich and A. H. Barnes
Colorado State University Hydrology Paper No 46, Nov 1970. 47 p, 16 fig, 4 tab, 6 ref, 3 append.

Descriptors: *Computer programs, *Flood routing, *Storm drains, *Numerical analysis, Mathematical studies, Routing, Equations, Unsteady flow, Mathematical models, Waves (water), Critical flow, Supercritical flow, Flow, Storm runoff.

Computer-oriented numerical methods are given for solving the Saint-Venant quasi-linear hyperbolic partial differential equations of gradually varied free-surface unsteady flow for storm drains. Various numerical finite-difference schemes, including explicit schemes based on the two partial differential equations, unstable diffusing, upstream differencing, leap frog, Lax-Wendroff, and the specified intervals scheme are analyzed. The specified intervals scheme (derived from the method of characteristics), the Lax-Wendroff scheme, and the diffusing scheme are compared. Flow charts and computer programs for these various numerical methods are given.

SECTION 4.

Sewer Systems

4a. Combined

050
FEASIBILITY OF A PERIODIC FLUSHING SYSTEM FOR COMBINED SEWER CLEANSING,
FMC Corp., Santa Clara, Calif. Central Eng Labs.

Final Report - Phase I, CE45363, Aug 1970. 48 p, 11 fig, 1 tab, 23 ref. FWQA Program No 11020DN008/67.

Descriptors: Sewers, Overflow, Conveyance structures, Storm drains, Water pollution control, Costs, Flow.
Identifiers: *Combined sewers, *Storm water overflow, *Flushing systems, *Sewer flushing, Sewer cleansing.

One of the causes of pollution from storm water overflow of combined sewers is the deposition of pollutional solids during the dry weather flow followed by pick up of the pollutional material during storm flow when the flow is bypassed. As a solution to this problem, it has been proposed that a flushing system be used to periodically cleanse the sewers during the dry weather and convey the solids to the treatment plant. Under Phase I a study was made of sewer flushing practices, application requirements, and hydraulic theory. Investigation was also made of sampling methods and equipment; flushing test equipment was designed for use in Phase II, and the cost of Phase II was estimated. It was confirmed that additional detailed information is needed to apply a periodic flushing system to actual combined sewers. It was also concluded that the existing information on sewer flushing indicated a good possibility that a periodic flushing system would be feasible for reducing pollution from combined sewer storm water overflow. The detailed information needed to apply a sewer flushing system must be determined by a large number of controlled experiments of flushing effectiveness. The design of flushing evaluation equipment for use in Phase II has been carried to the point where a cost estimate can be made for construction of the equipment. A description of the design and the cost estimates are included in this report.

051
THE CARDIFF EASTERN DISTRICT DRAINAGE SCHEME,

S. R. Salt
J Inst Munic Engrs (London), Vol 97, No 9, pp 246-254, Sep 1970.
8 fig, 2 ref.

Descriptors: *Sewerage, *Sewers, *Planning, *Drainage systems, Treatment facilities.
Identifiers: *Great Britain.

The area around Cardiff, Wales is serviced by three sewerage systems which have continued in use from the latter half of the 19th century until recently, with only one major change, despite expansion of the city. It was clear that a major renewal was required if further development on the east side of the city was not curtailed. The new plans would: 1) eliminate three storm overflows, 2) ensure far off-shore discharge, 3) provide for the screening of the total flow, and 4) maintain existing sewers. Thus the scheme, which is detailed herein, would include two runs of duplication sewers, a new pumping station, and a new sea outfall.

4b. Sanitary

052
RENEWAL IS VALID TERM IN BOSTON,

Public Works, Vol 101, No 7, pp 70-71, Jul 1970.

Descriptors: *Separation techniques, *Sewerage, *Storm drains, Construction materials, Urban renewal.
Identifiers: *Boston, Massachusetts, *Sanitary sewers.

As part of the Bay Village urban renewal project in Boston, the old sanitary and storm drain system was replaced with separate systems. Asbestos-cement pipes were used for the first time in Boston for the sanitary sewer. Reinforced concrete was used for the new storm drain, which parallels the sanitary sewer. Other public improvements in this area include resurfacing of streets, renewal of underground facilities, and installation of brick sidewalks and gas lamps.

053
ENGINEERING INVESTIGATION OF SEWER OVERFLOW PROBLEM; A Detailed Investigation Into the Cause and Effect of Sanitary Sewer Overflows and Recommended Remedial Measures for Roanoke, Virginia,
Hayes, Seay, Mattern & Mattern Architects - Engineers

FWQA Contract No 14-12-200, Program No 11024DMS, May 1970.
250 p, 10 plate, 101 fig, 60 tab, 31 ref, 8 append.

Descriptors: *Sewers, *Overflow, Infiltration, Storm runoff, Water pollution, Surveys, Computer programs, Flow measurement, Sampling, Construction costs.
Identifiers: *Roanoke, Virginia, *Sanitary sewers.

Three study areas, representing 25% of the area served by the City of Roanoke, Virginia's separate sanitary sewerage system, were used in an analysis of stream pollution resulting from rainfall infiltration and sanitary sewer overflows. Data from rainfall gauges were correlated with historical rainfall data to establish precipitation frequencies. Flows in the sanitary sewers and streams were gauged during storm events to measure infiltration and runoff quantities and to establish their relation to rainfall intensities and durations. Samples were obtained during storm events to assess the quality of sewer overflows and storm runoff. A computer program was developed to permit the analysis of the sewerage system under various rainfall frequencies and durations, to calculate the overflow quantities discharged to the watercourses, and to assess the sewer overflow problem for the entire urban area. Rates of infiltration in the sanitary sewers were found to be as high as 24,000 gallons per inch of pipe diameter per mile per day which produced overflows from a single event equivalent to 14% of the daily untreated sewage. Various remedial measures were investigated and a program, based primarily on reducing infiltration by at least 80%, was presented. The cost would be about $61 per capita.

054

60 YEAR-OLD SEWERS UPGRADED,

Sterling G. Brisbin
Water Wastes Eng, Vol 8, No 4, pp 47-49, Apr 1971. 3 fig, 2 tab.

Descriptors: *Sewage treatment, *Treatment facilities, *Activated sludge, Sewerage.
Identifiers: *Seneca Falls, New York, Seneca River, Sanitary sewers.

Seneca Falls, New York, has modernized its sewer system -- the activated sludge process is used. Sewage from the separate sanitary sewers is pretreated by a mechanically cleaned bar screen and a comminutor, then passes to primary settling tanks. The water then goes to mechanical surface aerators, and from there to the final settling tanks. It is then chlorinated and sent to the Seneca River. Waste sludge is degritted, thickened, digested and dried. Total costs for the new system were about $3,285,000.

055

SEWERAGE PRACTICES IN THE GULF COAST AREA,

John K. Mayer, Frank W. MacDonald, and Stephen E. Steimle
Public Works, Vol 101, No 8, pp 71-72, Aug 1970.

Descriptors: *Sewers, *Surveys, *City planning, Construction materials, Pipelines, Infiltration, Water table, Average flow.
Identifiers: *Sanitary sewers, *Gulf Coast, Treatment methods.

For the purpose of obtaining background information on sanitary sewers in the Gulf Coast areas, 71 municipalities and sewer districts spanning the coast from Texas through Florida were canvassed by questionnaire during the latter part of 1967 and the early part of 1968. The article describes the following results obtained from the survey: 1) type of sewers, 2) length of sewers, 3) pipe construction materials, 4) type of bedding used, 5) infiltration experience, 6) soil description and depth of water table, and 7) average flow and treatment used.

056

INFILTRATION IN SEPARATE SANITARY SEWERS; Determination, Economic Cost, and Correction Methods,

W. G. Riddle
J Water Pollution Control Fed, Vol 43, No 9, pp 1676-1683, Sep 1970.
4 fig.

Descriptors: *Pollution abatement, *Surveys, *Storm runoff, *Infiltration.
Identifiers: *Sanitary sewers, *Infiltration remedies.

The author has investigated the matter of eliminating both infiltration and stormwater which are serious pollution and economic problems afflicting most sanitary sewer systems. He contends that the elimination of stormwater from separate sanitary sewage systems is relatively easy, inexpensive, straightforward, and requires mainly education and effort. At the same time, reduction of infiltration is found to be more difficult and expensive. Several developments for reducing leakage that are less expensive than reconstruction include: two leak reduction methods, localized pressure grouting, and recent developments in testing and detector devices (for example low pressure air testing, and a 35-mm color camera).

057

TUNNELING SYSTEM PULLS INSTEAD OF PUSHING LARGE DIAMETER STEEL PIPE,

Jiro Wakabayashi
Construct Methods Equip, Vol 53, No 2, pp 96-100, Mar 1971.

Descriptors: *Installation, *Construction equipment, *Tunneling, *Methodology, *Steel pipes, Data collections.
Identifiers: *Sanitary sewers, *Japan.

A Japanese contractor has successfully used a U.S.-developed jacking system to pull some 200 feet of 96-inch diameter steel casing for a sewer line through the saturated subsoil of a creek without first cofferdamming, dewatering, or grouting the site. The Japan Development & Construction Company installed a 282-ft-stretch of sanitary sewer under an existing creek that runs through suburban Yokohama without disrupting its use as an open sewer for the surrounding houses. The pulling system used for installing the pipe consists of a circular steel jacking frame; 48, 15-ton hydraulic jacks mounted equidistant around the frame; and high strength pulling cables running from the jacks to points around the circumference of the pipe's cutting edge. Details of the construction procedure are given. A one-shift operation was worked on the subaqueous tunneling job while a daily compilation of data from a gage recording the thrust required by the system as the casing was pulled through the soil was delivered to the engineering department for analysis and evaluation as well as planning the next day's operation.

4c. Storm

058
1939 RUNOFF INSTRUCTIONS FOR DESIGN OF STORM DRAINS, OFFICE STANDARD NO. 71,

Los Angeles Bureau of Eng, 1966. 51 p, 23 fig, 8 tab.

Descriptors: *Drainage engineering, *Drainage practices, *Storm drains, *Storm runoff, *Design standards, Hydrology, Hydraulics, Rainfall-runoff relationships, Runoff forecasting, Drainage systems.
Identifiers: *Storm sewers, *Urban hydrology, Los Angeles, California.

The publication is an assembly of tables, curves, and instructions for computation of urban storm runoff and for designing urban storm water drains under various conditions of topography, imperviousness, soil types, slopes, and precipitation intensities. The material was first printed in 1939 to serve as an office standard in the Storm Drain Design Division of the Bureau of Engineering. This printing contains revisions to previous printings and adds several new parts including: a section titled "Hydrology of Steep Hillside or Mountainous Areas in Natural State", a formula for computing the adjusted time of concentration at junctions of a mainline storm drain with its laterals, and other charts and tables. Detailed instructions are given for applying the "peak rate" method and the method of "summing hydrographs" for computing runoff. Reduction factors to account for conduit detention in computing peak runoff flows are given.

059
COVENTRY CITY CORPORATION SEWERAGE AND SEWAGE TREATMENT,

Peter Beaumont
Surveyor, Vol 137, No 4100, pp 47-48, Jan 8, 1971.

Descriptors: *Overflow, *Storm runoff, *Treatment facilities, *Sewers, Construction, Storage tanks, Sewage treatment.
Identifiers: *Great Britain.

A $36 million program, begun in the 1950's, to replace the city's trunk sewers and major branch sewers is designed to end pollution caused from overflows in overloaded sewers during times of storm runoff. Storm water balancing stations are being provided to hold excess flow until it can be pumped back to the sewer when the storm is over. The extensions undertaken at the Finham sewage treatment works are discussed and emphasized are the workings of the treatment plants.

060
PLANNING STANDARDS FOR STORM DRAINAGE,

Myron D. Calkins (closure)
J Urban Planning Develop Div, Am Soc Civil Engrs, Vol 97, No UP1, pp 120-121, Apr 1971.

Original Paper: PLANNING STANDARDS FOR STORM DRAINAGE,
Myron D. Calkins
J Urban Planning Develop Div, Am Soc Civil Engrs, Vol 96, No UP1, pp 53-58, Mar 1970.

Descriptors: *Storm runoff, *Storm drains, Design, Standards, Design criteria.
Identifiers: *Storm sewers.

The author responds to a discussion by Duff and Hsieh, stating that the specific points raised in the discussion are more generally applicable to detailed design engineering for individual systems than to specific standards. He further states that the engineer must consider other utilities, maintenance procedures, and local effects in his design, and that the adoption of planning standards is not intended to replace adequate engineering design but to guide the production of integrated systems for entire metropolitan areas.

061
STORM SEWER ASSESSMENTS,

Richard R. Dague
Public Works, Vol 101, No 8, pp 62-66, 118, Aug 1970. 2 fig, 2 ref.

Descriptors: *Cost-benefit analysis, *Assessments, Runoff coefficient, Rainfall intensity, Drainage districts, Costs.
Identifiers: *Des Moines, Iowa, *Storm sewers.

The author presents a method of storm sewer assessment which was applied to a project in Des Moines, Iowa. Four benefit factors considered in apportioning property costs can be utilized in storm sewer assessment if the relative weight of each factor is determined by the relative benefit to be accrued. Other factors to be considered reflecting costs and therefore benefit are: (1) the area drained, (2) the runoff coefficient, (3) the rainfall intensity, (4) the distance to the outlet, (5) the unit pipe cost, and (6) the slope of the sewer.

Each of these factors are discussed in relation to a sub-area. Once the dollar benefit to each sub-area is determined, the benefit to individual properties within sub-areas must be ascertained. Also, in arriving at storm sewer assessment, the benefit accruing to public property must be considered. Means for evaluating all of these factors are thoroughly described. The Des Moines procedure outlined in this article does not necessarily have application to all storm sewer special assessment problems. The test of the method will come through its application to a variety of storm sewer assessment problems along with success in the courts.

062
STORM SEWER DESIGN,

F. D. Rickman
Paper presented at the National Conference Committee on Electronics, American Association of State Highway Officials, Austin, Texas, May 7-8, 1968. 23 p.

Descriptors: *Computers, *Computer programs, *Design, *Design criteria, Sewers.
Identifiers: *Storm sewers, *Storm sewer design.

The Fortran program was developed to design storm sewers from the basic data of rainfall, drainage areas, and pipe slopes and lengths. Storm sewer design lends itself to a computer operation because of the repetitive calculations involved in designing a complicated system of interconnected pipes. A program has been written in Fortran II for the IBM 1620 computer; a program for output listing was written for the IBM 1401 computer to give a better presentation to the designer and engineer. The storm sewer program is now being converted from Fortran II to Fortran IV.

063
RATIONAL "RATIONAL" METHOD OF STORM DRAINAGE DESIGN,

Richard A. Rogers (discussion)
J Irrigation Drainage Div, Am Soc Civil Engrs, Vol 96, No IR3, pp 342-343, Sep 1970.

Original Paper: RATIONAL "RATIONAL" METHOD OF STORM DRAINAGE DESIGN,
Richard A. Rogers
J Irrigation Drainage Div, Am Soc Civil Engrs,
Vol 94, No IR4, pp 465-480, Dec. 1968.

Descriptors: *Storm drains, *Flow rates, Computer programs, Methodology, Drainage systems, Design.

The writer has thus far been unable to comprehend, for the extreme case of a submerged storm system and assumed incompressible water, how the rate of flow out of the system at the outfall can differ from the rate of inflow at the inlets at any time. A lag time has been introduced into the computer program to allow for utilization of storage available within the system. The writer agrees with the thought that the design flows at individual points may be found from intensities occurring when peak flows reach the points, but he disagrees with the thought that the design for flows between the points can be made for the same hydraulic grade at different times.

SECTION 5.

Storm water - Quality, Quantity, and Pollution

5a. Caused from combined overflows

064

POLLUTION FROM COMBINED SEWERS; CINCINNATI, OHIO,

Arthur D. Caster and William J. Stein
Am Soc Civil Engrs Meeting, Preprint No 1090, 1970. 39 p, 13 fig, 5 tab.

Descriptors: *Sewage, *Storm runoff, *Waste treatment, Treatment facilities.
Identifiers: *Combined sewer overflow, *Cincinnati, Ohio.

The sampling and gaging program was designed to provide basic data to estimate the magnitude of combined sewage pollution in and from the Mill Creek Basin, and by extrapolation, the Cincinnati Service Area. The description of the Service Area, the background hydrological and water quality data, the field investigation program, the analysis of the data, and conclusions are presented herein.

065

QUANTITY AND QUALITY RELATIONSHIPS FOR COMBINED SEWER OVERFLOWS,

A. O. Friedland, T. G. Shea, and H. F. Ludwig
Fifth International Water Pollution Research Conference, San Francisco, Jul 26-Aug 1, 1970. Preprint Paper I-1. 16 p, 5 fig, 5 tab, 2 ref.

Descriptors: *Flow, *Hydrology, *Mathematical models, *Hydrographs, *Storm runoff, Waste water treatment, Water pollution, Water quality.
Identifiers: Combined sewage.

The results of a one-year program of wet and dry weather monitoring of five combined sewer systems and one storm sewer system in San Francisco, are presented. The time concentration profiles of combined sewage constituents follow a definite three-phase variation initially having characteristics of raw sewage increasing in the second phase to 125 to 200% of the characteristics of raw sewage, and receding in the third phase to levels of 10 to 25% of the characteristics of raw sewage. No correlation was found between the mass emission of constituents due to storm and the antecedent dry period, land use character, or rainfall intensity. Storm runoff emission equations for COD, total suspended solids, total nitrogen, and ortho-phosphate are included. Hexane extractable material and floatables can be used in conjunction with dry weather flow, waste load coefficient, a rainfall history, basin acreage, and population to estimate wastewater loads. Weather diversions contain twice the total nitrogen and orth-phosphate phosphorus, 50 to 60% more total nitrogen and COD, 20% more floatables, and 10% more total suspended solids than the storm runoff fraction of the diversion alone would contain. The nitrogen and phosphorus emissions from secondary forms are significantly greater than emissions of these constituents from combined or storm sewage flows on an annual basis.

066
SUGGESTED CORRELATION BETWEEN STORM SEWAGE CHARACTERISTICS AND STORM OVERFLOW PERFORMANCE,

G. Hedley and M. V. King
Inst Civil Engrs (London), Vol 48, pp 399-411, Mar 1971. 2 fig, 2 tab, 7 graph, 4 ref.

Descriptors: *Storm runoff, *Sewers, *Detention reservoirs, Biochemical oxygen demand, Suspended solids, Water quality, Sewerage.
Identifiers: *Storm overflows, Storage capacity.

This paper describes an investigation of the quantity and quality of storm runoff from a mixed area drained half on a combined and half on a partially separate system and a possible solution to the problem of river pollution from storm sewage overflows based on the results of this and other investigations. The basis of this method of preventing pollution is the provision of sufficient storage capacity at overflows to protect watercourses, even small ones, against severe summer storms. Also described is a scheme applying these ideas to a large existing area drained on the partially separate system and various practical problems are covered.

067
ASSESSING THE QUALITY OF URBAN DRAINAGE,

W. Viessman
Public Works, Vol 100, No 10, pp 89-92.

Descriptors: *Water quality, Model studies, Cities.
Identifiers: *Storm sewage, *Urban runoff, Cincinnati, Ohio.

The author reviews literature on the composition of urban storm sewage, including determinations at Cincinnati, Ohio and work on sediment loads, and considers ways of constructing water quality models for runoff from urban areas.

5b. Caused from storm runoff

068
FREEWAY RUNOFF TO BE TREATED,

Public Works, Vol 102, No 5, p 104, May 1971.

Descriptors: *Storm runoff, *Water treatment, *Michigan, Water treatment, Water pollution control.
Identifiers: Oakland County, Michigan, Macomb County, Michigan.

Storm water from I-696 in Oakland and Macomb counties in Michigan will be collected and processed before it is allowed to pass into Lake St. Clair. All pollutants except chlorides will be removed by a system that includes a skimming device, a storage chamber for the skimmed materials, a trash rack, and refinements which prevent spilled petroleum materials from entering the lake. The Michigan Department of Natural Resources and the FWQA speculate that the amount of chlorides entering the lake will not harm fish or plant life or recreation activities.

069
STORM WATER POLLUTION FROM URBAN LAND ACTIVITY; Development of Analytical Procedures for Predicting Storm Water Pollution from Urban Areas by Use of Selectively Defined Urban Characteristics,
Avco Economic Systems Corporation

FWQA Contract No 14-12-187, Program No 11034FKL, Jul 1970.
325 p, 66 fig, 89 tab, 28 ref, 14 append.

Descriptors: *Storm runoff, *Water pollution, *Water pollution sources, *Investigations, *Urbanization, *Pollutants, *Sampling, Cities.
Identifiers: *Tulsa, Oklahoma.

An investigation of the pollution concentrations and loads from storm water runoff in an urban area was conducted in Tulsa, Oklahoma. The scope of the project included: a field assessment of the storm water pollution by obtaining samples of the water resulting from precipitation and surface runoff from selected test areas within the metropolitan area; development of an analytical procedure for correlation of storm water pollution with selectively defined

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variables of land uses, environmental conditions, drainage characteristics, and precipitation; and development of a plan for implementing remedial measures necessary to abate or control sources of pollution in an urban area. Runoff samples were analyzed in terms of quality standards for BOD, COD, TOC, organic kjeldahl nitrogen, soluble orthophosphate, chloride, pH, solids, total coliform, fecal coliform, and fecal streptococcus pollutants. Selected land use parameters, environmental conditions, drainage and precipitation data, along with storm water pollution factors, provided input data for functional relationships enabling assessment of pollution from storm water runoff.

070

VARIATION OF URBAN RUNOFF WITH DURATION AND INTENSITY OF STORMS,

Robert C. Brownlee, T. Al Austin, and Dan M. Wells
Texas Tech University Water Resources Center Interim Rep No WRC-70-3, Sep 1970. 68 p, 12 fig, 30 tab, 10 ref.

Descriptors: *Storm runoff, *Water pollution sources, Urbanization, Sewage treatment, Statistics, Sewage disposal, Data collections, Hydrologic data.
Identifiers: Urban runoff, Combined sewers.

A great many cities transport raw domestic sewage to treatment facilities in the same sewer systems used to carry storm runoff from the streets. The storm runoff carried by these combined sewers, during even moderate rainstorms, can greatly exceed the capacity of municipal sewage treatment plants. This study was undertaken to determine the concentrations of pollutants carried by the storm runoff from a small residential watershed, and to consider the variations of pollutant concentrations with the duration of runoff. Surface runoff from rainstorms on the small residential watersheds contains pollutant concentrations which vary in average and extreme values from storm to storm. Average total dissolved solids and nitrates as well as the average pH value of storm runoff are within the USPHS standards for drinking water, while solids concentrations and total alkalinity concentrations are in the range of those found in raw sewage influent. Average BOD concentration of the samples tested is approximately the same as that of secondary sewage treatment effluent. Regression and correlation analyses indicate a definite reduction in constituent concentrations with duration of runoff. Rainfall intensities, antecedent moisture conditions, storm movements, and other parameters also influence this relationship.

071
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA,

Edward H. Bryan
North Carolina Water Resources Research Institute Rep No 37, Jun 1970.
43 p.

Descriptors: *North Carolina, *Water quality, Storm runoff, Surface runoff, Water quality control, Drainage, Urbanization, Surface drainage.
Identifiers: *Storm water drainage, Urban runoff.

The objective of this project was to determine the quality characteristics of storm water drainage from an urban land drainage basin in North Carolina as influenced by the nature of land use on the basin. The purpose of this study was to determine quantitative relationships between different land-use patterns and consequent differences in the water quality. The drainage basin selected has an area of 1.67 square miles and is in the upper portion of the Cape River Basin of North Carolina. Residential, commercial, and industrial activities on the selected basin are representative of the urban land-use pattern in North Carolina cities and towns. During the first year a gaging and sampling station was installed on the outlet of the major basin. In the second year, the major basin was divided into a number of subsidiary basins to characterize the quality of water draining from each sub-basin and attempt correlation of its qualities with land use. Urban storm water was found to be a significant source of pollutional constituents to receiving streams. With respect to BOD, the total weight contribution by storm water from this basin was estimated to equal that of its sanitary wastewater effluent from secondary treatment. The contribution of total organic matter as measured by chemical oxygen demand in its storm water was greater than that attributable to discharge of raw sanitary wastewater from a strictly residential, average urban area. The total solids contribution by urban storm water was substantially larger than would be expected from average raw domestic wastewater. The contribution of phosphate from this urban basin was nominal for urban storm water in comparison with that of domestic wastewater.

072
PROLONGED *SALMONELLA* CONTAMINATION OF A RECREATIONAL LAKE BY RUNOFF WATERS,

David G. Claudon, Donald I. Thompson, Eleanor H. Christenson, Gerald W. Lawton, and Elliot C. Dick

Appl Microbiol, Vol 21, No 5, pp 875-877, May 1971. 1 fig, 2 tab, 11 ref.

Descriptors: *Salmonella, *Storm drains, *Wisconsin, *Public health.
Identifiers: *Lake Mendota, Wisconsin.

Agricultural or urban runoff, even if thoroughly diluted, can be a regular contributor of *Salmonella* to recreational waters. In the summer and fall of 1968, various *Salmonella* serotypes were isolated from a portion of Lake Mendota, the major recreational lake for Madison, Wisconsin. The apparent sources of contamination were a residential storm sewer and a University of Wisconsin Experimental Farms' washwater drain, both of which empty into University Creek, the only influent stream on the southern shores of the lake. This is seen as a warning of the danger to health that urban and agricultural runoff can present.

073

EVALUATION OF DISPERSED POLLUTIONAL LOADS FROM URBAN AREAS,

Jerry Gay Cleveland
Ph.D. Thesis, 1970.

Descriptors: *Statistical models, *Cities, *Runoff, *Watersheds (basins), Okalhoma, Mathematical studies, Evaluation, Correlation analysis, Parametric hydrology.
Identifiers: *Urban runoff, *Tulsa, Oklahoma.

The objective of this study was to develop a technique of evaluating the dispersed pollutional loads from urban runoff. The technique involved analytically determining several pollutant parameters from twelve separate drainage basins, and then correlating the pollution levels to land use practices. The study used the statistical tools of correlation coefficients, component analysis, and multiple regression analysis to develop predictor models for estimating urban dispersed pollutional concentrations and loads. Separate mathematical equations for estimating the expected seasonal bacterial, organic, nutrient, and solid concentrations from urban runoff were developed. The predictors used in the equations were common urban area variables, such as population, population density, commercial establishment density, percentage of streets, and environmental index. Twelve mixed land use drainage basins located in the City of Tulsa, Oklahoma, were used as the test areas.

074

A METHOD FOR ASSESSING THE EXTENT OF POLLUTION FROM STORMWATER RUNOFF FROM AN URBAN AREA,

Donald L. Feuerstein

In: Selected Unbound Papers from the Water Pollution Control Federation Conference, Oct 4-9, 1970. 32 p, 3 fig, 2 tab, 4 ref.

Descriptors: *Storm runoff, *Sewerage, *Computers, *Waste water treatment, California, *Simulation analysis, *Water quality, Overflow, Water pollution sources, Cities.

A method is presented to assess the extent of water pollution occurring from storm water runoff and combined sewage overflows from an urban area from readily available data and information. Temporal distributions of storm water runoff flows and compositions are established from long-term historical rainfall records by means of hydrographic techniques and a storm water runoff quality simulation model. Temporal distributions of sanitary sewage are established by projection of available data, and are synchronously admixed with storm water runoff for combined sewage distributions. Wastewater characteristics are modulated and reduced by various water pollution control systems, and the distribution of receiving water quality characteristics are determined following discharge from the systems by computer simulation of transient conditions. Three system water quality criteria--maximum value criterion, cumulative distribution criterion, and excession frequency criterion--are applied to identify acceptably performing systems.

075
SOURCE CONTROL OF URBAN WATER POLLUTION,

James P. Heaney and Richard H. Sullivan
J Water Pollution Control Fed, Vol 43, No 4, pp 571-579, Apr 1971.
9 tab, 1 graph, 14 ref.

Descriptors: *Solid wastes, *Storm runoff, *Sewerage, Water pollution sources, Waste disposal.
Identifiers: *Chicago, Illinois.

This is a detailed analysis of sources of solid waste on a "typical" area in Chicago, Illinois and corresponding control facilities as part of an attempt to reduce water pollution resulting from storm water discharges and combined sewer overflows. A changeover to separate storm and sanitary sewer systems is not seen as a practical solution because of the expense involved and because storm water often also needs treatment. Solid waste sources are classified as air pollution, domestic wastes, garbage, other refuse, street sweepings, and catch basins. Estimated monthly and yearly totals from each source are given. A comparison of the costs of various methods of control indicates that it might be possible to reduce the use of catch basins, which are a potential source of storm water pollution, and that disposal of garbage with refuse may be more economical than its disposal through home garbage grinders.

076

EXTENT OF POLLUTION BY STORMWATER OVERFLOWS AND MEASURES FOR ITS CONTROL,

K. Inaba
Fifth International Water Pollution Research Conference, San Francisco,
Jul 26-Aug 1, 1970. Preprint Paper HA-8. 7 p, 4 fig, 1 ref.

Descriptors: *Water pollution, *Storm runoff, *Sewage, *Hydrology, *Hydrographs, Ponds, Waste water treatment, Mathematical models, Sewerage.
Identifiers: *Combined sewage, *Japan.

A study of the quantity and quality of storm sewage from a combined sewerage system in Tokyo metropolis was conducted in the period 1966-1967. Three interconnected aspects of the study are discussed: 1) the hourly variation of storm sewage and storm water quality and quantity in urban areas, 2) some considerations on the method of estimating these factors, and 3) the control of storm sewage flow and quality. It is important to estimate the hourly variation of storm sewage or storm water quality as a function of rains at all intensities so that accurate measures can be taken for control based on a sound mathematical model. Several possibilities are investigated and it is concluded that in a combined system it is most economical and reasonable to divide the total pollution in storm sewage between the outfall sewer to the treatment works, a storage tank, and storm sewage outflows.

077

A SYSTEMS STUDY OF STORM RUNOFF PROBLEMS IN A NEW TOWN,

Charles W. Mallory and John J. Boland
Water Resources Bulletin, Vol 6, No 6, pp 980-989, Nov-Dec 1970.
4 tab, 7 ref.

Descriptors: *Storm runoff, *Urbanization, *Systems analysis, *Simulation analysis, Mathematical models, Computer models, Water pollution control, Water supply, Optimization, Water reuse, Sediment control.
Identifiers: *Columbia, Maryland, *Urban hydrology.

A system study was conducted on the use of a large number of small reservoirs dispersed throughout an urban community as a means of storm water pollution control. The study was based on an area within the 'new city' of Columbia, Maryland. Water collected and stored in the reservoirs is treated for release or use in meeting subpotable and potable water demands in the community. Design and performance criteria were developed for such a system. A simulation model and a computerized evaluation technique were used to select the optimal locations and system configurations. The results of this study indicated that such a system would be less expensive than a conventional engineering approach to storm water pollution control. Further, the benefits derived from use of the storm water as a water supply can offset a portion of the cost of pollution control. Several secondary benefits also result from this concept including erosion and sediment control, storm flow dampening, and recreational facilities. A program is now underway to demonstrate this concept in Columbia, Maryland.

078
THE EFFECTS OF URBAN DRAINAGE ON LAKE McILWAINE, RHODESIA,

J. McKendrick and R. K. Williams
Water Pollution Control, Vol 68, pp 523-528, 1969.

Descriptors: *Water quality, Water treatment, Effluents, Investigations, Water pollution sources.
Identifiers: *Rhodesia, *Urban runoff, Algal growth.

From 1953 to 1959 there was little change in the quality of the water in lake McIlwaine, which is the main source of supply for Salisbury, Rhodesia, but from 1960 trouble began to be experienced with heavy algal growths which interfered with treatment of the water. When the lake water intake level was lowered to avoid the algae, problems were caused by manganese and iron in the lower waters of the lake. Studies on conditions in the lake showed that the algal growths were caused by high concentrations of phosphate and nitrogen brought into the lake by the rivers to which the effluents from the city's sewage works and oxidation lagoons were discharged; algal growths were most severe during periods of low rainfall when less dilution was available.

079
DETERMINATION OF THE POLLUTIONAL EFFECT OF SURFACE RUNOFF,

N. A. Pravoshinsky and P. D. Gatillo
In: Advances in Water Pollution Research, Proceedings 4th International Conference on Water Pollution Research, Prague, Czechoslovakia, Apr 21-25, 1969, Pergammon Press, Ltd, pp 187-195, 1969. 3 fig, 1 tab, 27 ref.

Descriptors: *Water pollution sources, *Cities, *Storm runoff, *Surface runoff, *Urbanization, Water pollution effects, Foreign research.
Identifiers: *USSR.

Pollution by urban surface runoff depends on the intensity of movement of street traffic and use by pedestrians, type of cover of catchment, duration and intensity of rain, standards of water discharge of watering and washing, the amount of dust deposition, the elevation of the catchment water basin, duration of preceeding dry weather period, quality and technology of town cleaning, and the means of dust control. Data were compiled from samples collected in the well-built-up districts of Minsk, USSR, remote from big industrial enterprises and Soligorsk, a rapidly developing town. The value of 5-day BOD was used as a primary index of runoff pollution. In addition the concentrations of suspended solids, chlorides, oil-products, and bacterial pollution were determined.

080

URBAN SOURCES OF NITRATE,

James M. Symons
Illinois University Urbana Bulletin, Vol 68, No 2, pp 78-85, Aug 5, 1970. From 12th Sanitary Engineering Conference Proceedings on NITRATE AND WATER SUPPLY: SOURCE AND CONTROL, Urbana, Illinois, Feb 11-12, 1970.

Descriptors: *Industrial wastes, *Urbanization, *Storm runoff, *Sewage, *Water supply, *Nitrates.
Identifiers: *Nitrogen sources.

The urban sources of nitrate nitrogen are dealt with, and data on nitrite, nitrogen, ammonia, and organic nitrogen are included in the study since they can be partially or totally biologically oxidized to the nitrate form. The sources of urban nitrogen include human wastes from individual and central sewage systems, runoff from separate and combined storm water systems, rainfall, and industrial wastes. These sources are discussed in terms of the quantities and concentrations of readily biologically oxidizable nitrogen they contribute, and the degree of dilution each has to undergo in meeting with United States Public Health Standards requirements for nitrate nitrogen in drinking water supplies.

081

URBAN DRAINAGE AS A FACTOR IN EUTROPHICATION,

S. R. Weibel
Paper presented at the International Symposium on Eutrophication, Madison, Wisconsin, Jun 11-15, 1969. 20 p, 2 fig, 9 tab, 31 ref.

Descriptors: *Sewage, *Storm runoff, *Water pollution sources, *Urbanization, *Nutrients, *Overflow.
Identifiers: *Combined sewers, *Urban drainage.

In this article the topic of urban drainage includes sewage as well as storm water runoff and combined sewer overflows. Since current research activities on the control of nutrients in connection with sewage treatment seem well documented, this paper is devoted to storm water runoff and combined sewer overflows as sources of water pollution, including nutrient contributions, an area of study where much work is needed. The urbanization explosion means that more people, more demands for water for all purposes, more wastes, more storm water runoff--all are impressed upon existing time, space, facilities, and habits already representing huge investments.

SECTION 6.

Surveys, Policies, and Reports

082
WORKING PARTY ON STORM SEWAGE,

Effluent Water Treat J, Vol 11, No 1, p 49, Jan 1971.

Descriptors: *Sewage treatment, *Storm runoff, *Surveys, Overflow, Storage tanks, Investigations.
Identifiers: *Scotland.

The Scottish Development Department has formed a committee to study the subject of storm sewage in relation to its conditions and practices in Scotland. They will investigate the operation of storm overflows and tanks and the influence of storm sewage on the efficiency of sewage treatment.

083
A REVIEW OF THE 1969 LITERATURE ON WASTEWATER AND WATER POLLUTION CONTROL: WASTEWATER AND STORM FLOW TREATMENT,

Research Committee
J Water Pollution Control Fed, Vol 42, No 6, pp 963-969, Jul 1970.
42 ref.

Descriptors: *Equipment, *Construction materials, *Treatment facilities, Overflow, Construction, Sewers, Technical feasibility, Sewerage, Storm runoff, Separation techniques, Water pollution.
Identifiers: *Treatment methods, Combined sewers.

This section of the review of 1969 literature discusses the construction of new sewerage systems and improvements made in existing systems in large and small cities. New construction methods, materials, and safety programs, are described along with new sewer maintenance and repair programs and methods, and new techniques and equipment for handling combined sewer overflows including rubber storage tanks, stabilization basins, regulators, treatment facilities, hydraulic additives, pressurized sewers, and the removal of downspout connections. The feasibility of sewer separation, pollution parameters from surface runoff, sewer project planning, and changes in sewer systems are other topics included in the literature review on wastewater and storm flow.

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084
$37 BILLION: NEW PRICE TAG FOR CITIES' WATER POLLUTION CONTROL COSTS,

Nation's Cities, Vol 8, No 8, pp 8-9, Aug 1970.

Descriptors: *Estimated costs, *Cost allocation, *Cost analysis, *Cost comparisons, *Cost sharing, *Costs, *Cost trends, *Cities, *City planning, *Sewers, *Water resources development, *Legislation, Treatment facilities, Storm runoff, Overflow, Separation techniques.
Identifiers: *Storm sewers.

The National League of Cities (NLC) and the United States Conference of Mayors (USCM) estimated between $33 billion and $37 billion will be needed to combat water pollution between 1970 and 1976, as reported by Senator Muskie, in comparison with FWQA reports of $10 billion over the five year span, 1970-1974. The NLC-USCM survey asked for specific cost data categorized in the following manner: 1) needs for primary and secondary treatment facilities; 2) needs for tertiary treatment facilities; and, 3) needs for interceptor and storm sewers, including projected costs of separating storm and sanitary sewers, and/or storing storm water overflows. The survey covered 1,008 communities with a combined population of approximately 89.4 million. Based on the projection from this survey, the NLC and USCM estimated the total national needs for state and local water pollution control facilities for the next six years which includes a five percent inflation factor. Discussion on past, present, and future legislative action is included, and a cost chart based on survey results is given.

085
STORMWATER QUALITY,

Public Works, Vol 102, No 1, pp 99, Jan 1971.

Descriptors: *Surveys, *Investigations, *Storm runoff, *Water quality, Drainage systems, Urbanization, North Carolina, Sampling, Water pollution, Water pollution sources, Flow rates.
Identifiers: *Parametrics.

This is a synopsis of a report conducted by E. H. Bryan at the Water Resources Research Institute of the University of North Carolina which investigated the "Quality of Stormwater Drainage from Urban Land Areas in North Carolina". This project was undertaken to evaluate the quality characteristics of storm water runoff from a 1.67 square mile drainage basin within the city of Durham, North Carolina. Parameters selected for routine examination included total solids, volatile total solids, BOD, COD, chloride, soluble phosphate, total phosphate, fecal coliform counts, and lead. Flows were sampled from approximately 30 storms among 70 which occurred over a period of fourteen months. Results obtained indicated that: discharged BOD is estimated at 0.23 pound/acre/day; COD measures at 2.85 pounds/acre/day; total solids contribution is substantially larger than expected from raw domestic sewage; pollutants are discharged in slugs during and immediately following storms; pesticide analyses indicate a total concentration of 1.16 ppb; and, lead concentration of the runoff averaged 1190 lbs/sq. mile for an annual yield.

086

METROPOLITAN BOSTON'S WASTEWATER QUALITY CONTROL PROGRAM,

Water Sewage Works, Vol 117, No 9, pp 300-304, Sep 1970.

Descriptors: *Water pollution sources, *Overflow, *Legislation, *Treatment facilities, Pollution abatement, Water quality control.
Identifiers: *Storm overflows, *Boston, Massachusetts.

This paper traces the historical factors contributing to the sewage problems in Boston, Massachusetts and accredits the general causes for the pollution conditions to: 1) the raw sewage discharge into Boston Harbor, and 2) mixed sewage and storm water overflow into tributary rivers, streams, and basins. Pertinent sections of legislation authorizing pollution control construction as well as associated legislative acts are mentioned. A description of existing sewage treatment plants and important features of the improvement programs is given. A new anti-pollution installation on the Charles River, expected to be undergoing acceptance and evaluation tests in late 1970, will accumulate, detain, and chlorinate overflow from combined sewage and surface drainage occurring during heavy storms.

087

CONTROL OF INFILTRATION AND INFLOW INTO SEWER SYSTEMS,
American Public Works Association

EPA/WQO Contract No 14-12-550, Program No 11022EFF, Dec 1970. 121 p, 12 fig, 43 tab, 135 ref.

Descriptors: *Sewerage, *Infiltration, *Inflow, *United States, Surveys, Design, Investigations.
Identifiers: *Canada, Construction allowance.

Two hundred and twelve public jurisdictions in the United States and

Canada were contacted, and twenty-six communities were visited. Practices of consulting engineers and state and provincial water pollution control agencies were also surveyed. The surveys indicated that infiltration and inflow are widespread problems. Reduction of infiltration should be stressed in both new and old systems. For new sewers a construction allowance of no more than 200 gallons per day per inch of diameter per mile of pipe is recommended. Existing systems must be extensively investigated to determine the extent and location of infiltration. Reduction of inflow waters can be accomplished after sources of such flows have been identified, alternate methods of disposal identified, and the backing of public and governing bodies secured. Twenty recommendations are given indicating the need for extensive investigation of the extent of the infiltration/inflow problem before relief sewers are constructed or wastewater treatment plants built or enlarged.

088

COMBINED SEWER REGULATOR OVERFLOW FACILITIES; Report,
American Public Works Association

FWQA Contract No 14-12-456, Program No 11022DMU, Jul 1970.
139 p, 38 fig, 29 tab, 4 append.

Descriptors: *Overflow, *Regulation, Design, Operations, Maintenance, Control systems.
Identifiers: *Combined sewers, Tide gates, Overflow quantity, Overflow quality.

Current design, operation, and maintenance practices used by local jurisdictions in the United States and Canada were determined by personal interviews and compiled in this report. Particular attention was given to the performance of various types of regulators, the use of tide gates, new designs, European practices, and the systems concept of combined sewer regulation. Thirty-seven drawings and photographs of regulators are included. 17 recommendations are made, the adoption of which would upgrade regulator facilities and tend to reduce receiving water pollution from combined sewer overflows.

089

COMBINED SEWER REGULATION AND MANAGEMENT; A Manual of Practice,
American Public Works Association

FWQA Contract No 14-12-456, Program No 11022DMU, Jul 1970.
134 p, 41 fig, 1 tab.

Descriptors: *Overflow, *Regulation, Design, Operations, Maintenance, Control systems.

Identifiers: *Combined sewers, Tide gates, Overflow quantity, Overflow quality.

Design application, operation, and maintenance of combined sewer overflow regulator facilities are detailed in this Manual of Practice, developed in conjunction with a report prepared on combined sewer overflow regulators. Design calculations are given for various types of regulators and tide gates. A sample regulator facility control program is given to illustrate the development of a control system. Operation and maintenance guidelines are also given. Thirty-eight sketches and photographs are included.

090
CONCEPTUAL ENGINEERING REPORT: KINGMAN LAKE PROJECT,
Roy F. Weston, Inc., West Chester, Pennsylvania

FWQA Contract No 14-12-829, Program No 11023FIX, Aug 1970. 149 p, 7 fig, 23 tab, 25 ref, 5 append.

Descriptors: *Filtration, *Flow measurement, *Rainfall-runoff relationships, *Recreation facilities, Rainfall intensity, Depth-area-duration analysis, Storm runoff, Overflow, Organic loading, Pollutants, Standards, Waste water treatment, Activated carbon, Sewers, Tunnel design, Technical feasibility, Annual costs, Capital costs, Cost-benefit analysis, Water storage, Water reuse, District of Columbia, Pollution abatement.
Identifiers: *Combined sewers.

This conceptual engineering study concerns the reclamation of combined sewer overflows and utilization of the reclaimed waters in a major water-oriented recreational facility for the District of Columbia. The investigation encompasses a comprehensive solution of environmental problems by proposing multi-use objectives and facilities. Principal objectives of the project include: 1) evaluation of rainfall-runoff relationships for sizing of storage and treatment plant capacities; 2) confirmation of treatment feasibility using filtration and an activated carbon process; and 3) development of sufficient data for preliminary design purposes. Laboratory studies not only demonstrated process feasibility, but showed the need for including flocculation and sedimentation for removal of minute particles, together with chlorine and iodine addition for maximum disinfection. The recommended storage/treatment plan provides for a 175 million gallon storage basin, a 50 million-gallon/day reclamation facility, and two 46-acre swimming and boating lakes. Cost effectiveness (cost/benefit ratio) of the project, as envisioned, has been indicated to be 1.6 at an estimated total project cost of $45,200,000, and an estimated annual operating cost of $1,777,000. Implementation of the proposed plan would not only provide a least-cost alternative over single-purpose projects to attain identical objectives, but would also reduce the annual pollution now discharged by the Northeast Boundary Trunk Sewer by approximately 99 percent.

091
THE ENVIRONMENTAL DECADE (ACTION PROPOSALS FOR THE 1970's): From the Conservation and Natural Resources Subcommittee,
Committee on Government Operations

Hearings before the Committee on Government Operations, 91 Cong, 2d Sess, Feb 2-6, Mar 13, and Apr 3, 1970. 367 p.

Descriptors: *Environmental engineering, *Separation techniques, *Sewers, *Waste treatment, *Treatment facilities, *Pollution abatement, *Water pollution control, *Standards, *Waste disposal, *Soil erosion.
Identifiers: *Proposals, *Funding, *Air pollution control, *Environmental control.

Congressional testimony is reported on proposals for the 'Environmental Decade of the 1970's'. The proposals include adequate funding for waste treatment plants, separation of storm and sanitary sewers, development of desalinization and recycling, the prevention of waste by evaporation and other causes, elimination of sources of pollution, preservation of wetlands and estuaries, development of pollution-free automotive engines as alternatives to present internal combustion engines, standards for industrial and power plants in elimination of polluting discharges, elimination of agricultural soil erosion and siltation from highway construction and suburban development, control of chemical pollution from the use of fertilizers, standards for regional and national planning, and strict controls for solid waste disposal.

092
RECOMMENDED REGIONAL PLAN FOR SEWERAGE, WATER SUPPLY AND STORM DRAINAGE, Valley Regional Planning Agency, Ansonia, Conn.

HUD Project Conn. P-103, Feb 1970. 60 p, append.

Descriptors: *Urbanization, *Planning, *Connecticut, *Sanitary engineering, Sewage, Drainage, Floods, Water supply.
Identifiers: *Storm sewers.

The report presents the recommended regional plan and program for sewerage, water supply, and storm drainage for the 58 square mile Valley Planning Region, comprising Ansonia, Derby, Seymour, and Shelton, Connecticut.

093
STORM DRAINAGE: INVENTORY AND ANALYSIS OF MAJOR EXISTING AND PLANNED FACILITIES. VOLUME V: STORM DRAINAGE,
Valley Regional Planning Agency, Ansonia, Conn.

HUD Project Conn. P-103, Feb 1970. 18 p.

Descriptors: *Urbanization, *Planning, *Connecticut, *Drainage, *Sewers, Floods, Sewage, Sanitary engineering.
Identifiers: *Storm sewers.

This is the fifth of a five-volume report that is being utilized as part of the basis for an areawide water/sewer plan and program for the Valley Region. This volume includes an inventory and evaluation of the major existing and planned facilities. The inventory includes a delineation of present areas served by storm sewers and areas requiring flood protection. (See abstract number 115.)

094
REPORT OF INVESTIGATION FOR PLANNING SEWER SYSTEM AROUND LAKE BIWA,

Japan Sewage Works Association, Jan 1971. 318 p.

Descriptors: *Water quality, *Lakes, *Sewerage.
Identifiers: *Japan.

At the request of the Ministry of Construction in October 1969, the Japan Sewage Works Association investigated Lake Biwa prior to planning a sewer system around the lake. Because the water quality of Lake Biwa is deteriorating year after year, an optimum sewer system has been planned. The lake is not only the largest in Japan but also the source of water for the Kinki region. The population in the area of the lake was 850,000 in 1965 and is expected to reach 1,150,000 by 1985. Water remains in the lake an average of five years, thus deterioration by organic pollution and unusual growth of weeds due to nitrogen and phosphorus inflow must be taken into consideration. For effective control of pollution of the lake from the 240 sq km area around the lake, there must be a regional sewer system transcending prefectural borders. In the investigation, a system planning method was applied to determine the basic policy on blocking the sewer system plan. In view of the predicted water quality of the northern lake area, control of nutrient salts will become necessary within 10 years. However, the technology of eliminating nitrogen and phosphorus is still to be developed. The results of a simultaneous investigation by the Civil Engineering Society on "The prediction of water quality of Lake Biwa" were incorporated. It is suggested in planning the sewer system that Shiga Prefecture be divided into eight blocks, each block being one unit of the system.

095
ECORSE RIVER WATER QUALITY STUDY, MAY-JULY, 1969,

Michigan Water Resources Commission, Lansing. Dept of Natural Resources, Aug 1969. 41 p, 12 fig, 9 tab, 2 ref.

Descriptors: *Water quality, *Surveys, *Storm runoff, *Overflow, Water pollutuion sources, On-site investigations, Pollutant identification, Benthos.
Identifiers: *Combined sewers, *Ecorse River, Michigan.

A survey was initiated in May 1969 to evaluate the present water quality of the Ecorse River and relate existing conditions to cause. The Ecorse River Basin is located in a densely populated portion of southeastern Michigan. Its natural drainage area of 46 square miles is located entirely in Wayne County and includes portions of the southern Detroit metropolitan area. The North Branch and the South Branch join to form the main stream three-fourths of a mile west of the Detroit River. The studies confirmed that the lower Ecorse River system is in a severely degraded condition. The principal factors causing degradation are storm water overflows which originate from combined sewer systems. High biochemical oxygen demand of the Benthic sludge, combined with the BOD of suspended materials and algal respiration, caused extremely low dissolved oxygen levels during the survey. Biological studies of the plankton community revealed excessive algal densities, 93 percent of which were bluegreens.

096
POLLUTIONS AND TOKYO METROPOLITAN GOVERNMENT,

Tokyo Metropolitan Res Inst Environ Protection, Jun 1970. 724 p.

Descriptors: *Water quality, *Biochemical oxygen demand, *Rivers, *Aquatic life, *Sewerage, *Treatment facilities, *Industrial wastes, *Legislation, *Monitoring.
Identifiers: *Japan.

All but one of the major rivers in Tokyo come under the Water Quality Maintenance Law. The biochemical oxygen demand (BOD) in areas of these waters exceeds 5 ppm, making the existence of fish impossible. Certain tributaries have a BOD of 28-54 ppm. Some improvement has occurred in the River Sumida, but its BOD still exceeds 10 ppm and generates an obnoxious odor. Pollution of other rivers has accelerated in varying degrees. Inner Tokyo Bay, comprising 109,000 ha, was once adequately enriched with nutrients and its seaweed and seashell cultures were among the finest in Japan in terms of quality and quantity. In 1955, however, the seashells started to die and the seaweed began to deteriorate. Nevertheless, reclamation of the Bay to make room for piers and industrial sites continued. Though partly caused by effluent from coastal factories and bilge water from ships, pollution of the sea is mainly due to the polluted river water flowing into Tokyo Bay. Construction of a public sewer system to reduce river pollution has been delayed. As of March 1969, only 40% of the population of central Tokyo and only 6.8% of that in the hinterland were served by a sewer system. It is hoped that the figure will be 100% in central Tokyo by 1979. A sewer system serving 17 cities and 10 towns with a total population of 4.4 million will be installed in the hinterland in 1985. Currently, most factory effluent is under the control of regional governors, while the national government controls that of such large-scale industries as sake breweries, paper processing, and iron and steel plants. Factories not covered under the Water Quality Maintenance Law are controlled by the Tokyo Metropolitan Pollutions Control Ordinance. New housing areas with a population density of 300-600/ha have wastewater treatment facilities, and the treated water is of the same quality as that of terminal treatment plants in public sewer systems. The 1968 minimum for BOD was 1.5 ppm in rivers from which water was taken and less than 10 ppm in other rivers. Attainment of these levels will require the establishment of an overall control system involving monitoring of river water, effluent treatment, adjustment of water flow, and artificial acceleration of the self-purification function.

097
A MULTI-PHASE COMPONENT STUDY TO PREDICT STORM WATER POLLUTION FROM URBAN AREAS,
AVCO Economics Systems Corporation

U.S. Dept Interior, Office Water Resources Res, Contract No 14-31-0001-3164, Dec 1970. 262 p, 20 fig, 71 tab, 40 ref, 4 append.

Descriptors: *Storm runoff, *Forecasting, *Model studies, *Cities, *Watersheds (basins), *Sewerage, Investigations, Water pollution sources, Water pollution control, Evaluation, Cost-benefit analysis.

Attempts were made to develop storm water pollution prediction models applicable in different regions of the country and criteria for urban storm water pollution control strategies. Existing prediction models were evaluated and additional ones developed. Appropriate urban runoff pollutional models were validated by application to four demonstration cities. Refinements that could broaden the scope of use of the storm water prediction models are indicated, and an evaluation is made of various structural and nonstructural control methods for both undeveloped and developed drainage basins. Costs and the general effectiveness of these procedures are presented. Guidelines for use of the procedures, as well as guidelines for the selection of an optimal control plan, are discussed. Two salient conclusions of the study are: (1) storm water pollution prediction models applicable in a wide variety of areas cannot be developed until additional data on the hydrological, precipitation, and runoff quality characteristics of representative metropolitan areas become available; and, (2) control strategies can be chosen only after the specifics of the area are defined in terms of the sewer hydraulics, topography, geology, land use patterns, availability of construction sites, land costs, rainfall and runoff characteristics, location of drainage outlets, and water quality standards for the receiving waters.

098

STREAM POLLUTION AND ABATEMENT FROM COMBINED SEWER OVERFLOWS: BUCYRUS, OHIO,

Burgess and Niple, Limited

U.S. Dept Interior, FWQA Contract No 14-12-401, Program No 11024FKN, Nov 1969. 197 p, 23 fig, 30 tab, 66 graph, 59 ref.

Descriptors: *Overflow, *Storm runoff, *Sewerage, *Drainage, *Hydrography, *Infiltration, *Streamflow, *Aeration, *Oxidation lagoons, Lake Erie, Rainfall, Flow, Biochemical oxygen demand, Suspended load, Coliforms.
Identifiers: *Sandusky, Ohio, *Bucyrus, Ohio, *Combined sewers, *Urban runoff, *Interceptor sewers, Waste water analysis.

This report contains the results of a detailed engineering investigation and comprehensive technical study to evaluate the pollution effects from combined sewer overflows on the Sandusky River at Bucyrus, Ohio and to evaluate the benefits, economics, and feasibility of alternate plans for pollution abatement from the combined sewer overflows. A year long detailed sampling and laboratory analysis program was conducted on the combined sewer overflows in which the overflows were measured and sampled at 3 locations comprising 65% of the City's sewered area and the river flow was measured and sampled above and below Bucyrus. The results of the study show that any 20 minute rainfall greater than 0.05 of an inch will produce an overflow. The combined sewers will overflow about 73 times each year discharging an estimated annual volume of 350 million gallons containing 350,000 pounds of BOD and 1,400,000 pounds of suspended solids. The combined sewer overflows had an average BOD of 120 mg/l, suspended solids of 470 mg/l, total coliforms of 11,000,000 per 100 ml and fecal coliforms of 1,600,000 per 100 ml. The BOD concentration of the Sandusky River, immediately downstream from Bucyrus, varied from an average of 6 mg/l during dry weather to a high of 51 mg/l during overflow discharges.

The suspended solids varied from an average of 49 mg/1 during dry weather to a high of 960 mg/1 during overflow discharges. The total coliforms varied from an average of 400,000 per 100 ml during dry weather to a high of 8,800,000 per 100 ml during overflow discharges. Various methods of controlling the pollution from combined sewer overflows are presented along with their degree of protection, advantages, disadvantages and estimates of cost. The methods presented include (1) complete separation, (2) interceptor sewer and lagoon system, (3) stream flow augmentation, (4) primary treatment, (5) chlorination, and (6) offstream treatment. It was concluded that the most economical method of providing a high degree of protection to the Sandusky River is by collecting the combined sewer overflows with a large interceptor and using an aerated lagoon system to treat the waste loads from the overflows.

099

FEASIBILITY OF A STABILIZATION-RETENTION BASIN IN LAKE ERIE AT CLEVELAND, OHIO,
Havens and Emerson

U.S. Dept Interior, FWPCA Contract No 14-12-27, Program No 11020---, May 1968. 5 fig, 13 tab, 4 graph, 38 ref, 3 append.

Descriptors: *Feasibility studies, *Stabilization, *Retention, *Lake Erie, *Overflow, *Waste water treatment, *Treatment facilities.
Identifiers: *Combined sewers, *Treatment methods, *Cleveland, Ohio.

A feasibility study was conducted of a large stabilization-retention basin to be constructed on Lake Erie at Cleveland, Ohio. Stabilization is viewed as a possible alternative to separation of combined sewer systems. The proposed basin would treat flows from a number of large combined sewer overflows, from several polluted streams, and effluent from a large secondary wastewater treatment plant. Treatment would consist of bio-oxidation, sedimentation, stabilization, and disinfection. A shoreline collection system is included to convey flows to the basin. The chemical, biological, physical, and structural aspects of the proposed basin were studied, and the probable benefits to water quality and the effectiveness of the basin were evaluated. Estimates of cost of the basin and collection system were prepared, and it was concluded that the stabilization basin would provide a higher degree of pollution abatement than would separation of sanitary and storm sewers, at about one-third the cost.

100

CONTROL OF POLLUTION BY UNDERWATER STORAGE: Feasibility of Providing Temporary Underwater Storage of Storm Overflow from a Combined Sewer System,

Underwater Storage, Inc. & Silver, Schwartz, Ltd. - Joint Venture

U.S. Dept Interior, FWPCA Contract No 14-12-139, Program No 11022DWF, Dec 1969. 20 fig, 9 tab, 34 graph, 12 ref, 1 append.

Descriptors: *District of Columbia, *Drainage water, *Waste storage, *Pilot plant, *Water storage, *Storage tanks, *Storm runoff, *Overflow, *Sewerage, *Hydrology, *Flow, *Pumping plants, *Feasibility studies, Venturi flumes, Water treatment.
Identifiers: *Underwater storage, *Combined sewers, *Rubber storage containers.

A pilot plant was designed, constructed, and operated to assess the feasibility of providing a facility for the collection, treatment, storage, and final disposition of a portion of the storm overflow from a combined sewer system serving a thirty-acre drainage area in Washington, D. C. A Parshall flume was installed in the overflow line for measurement of flow rates and determination of total overflow volume. A portion of the overflow was diverted to the pilot plant through grit chambers and a comminutor. Flow was stored in two 100,000-gallon underwater bags fabricated of nylon reinforced synthetic rubber and fastened to the river bed by a system of patented anchors. During the period of storage, compressed air was delivered to the tanks for agitation of the solids. Following cessation of the storm, contents of the bags were pumped to the interceptor sewer for delivery to the District of Columbia Sewage Treatment Plant at Blue Plains. Flow into and out of each underwater storage tank was metered and recorded. Samples of the combined sewage overflow discharged to the bags and pumped discharge from the bags were collected and subjected to laboratory analyses. During the operation period from January through September, 1969, a total of 1,600,000-gallons of diverted overflow from 38-storms was stored in the tanks. In addition, 600,000-gallons of river water was pumped into the underwater storage tanks for testing during dry weather periods. The total amount stored was pumped to the interceptor sewer in 26-separate pump out periods. The cost of the pilot plant was $341,480.00, or $1.70 per gallon of storage. This included facilities for testing, samples and flow measurement. Estimates for larger installations, without these special requirements range from 28.2¢ to 14.6¢ per gallon for plants with storage from two to twenty million gallons. The project demonstrated that temporary storage of overflow from combined sewers in underwater rubber storage tanks is feasible and may, under suitable conditions, be effective in eliminating direct, untreated discharge of combined sewage into surface waters during storm periods.

Drainage area to be served, land use, nature of storm events, and other factors must be considered when planning an underwater storage facility.

101

SEWAGE FACILITIES CONSTRUCTION, 1969,

U. S. Dept Interior, FWQA publication, 1969. 50 p, 31 tab, 2 append.

Descriptors: *Sewage treatment, *Sewerage, *Contracts, *Sewage disposal, Costs, Sewers.

Data on sewage treatment and collection sewers contracts awarded by municipalities, special districts, and other local governments of the United States for facilities used in disposing domestic waste and such industrial wastes as directed are detailed herein. This collection provides successful water pollution control measures and indicates year-to year cost trends related to the public works construction undertaken.

102

PROCEEDINGS OF THE THIRD SESSION OF CONFERENCE IN THE MATTER OF POLLUTION OF INTERSTATE WATERS OF THE POTOMAC RIVER AND ITS TRIBUTARIES (WASHINGTON METROPOLITAN AREA)--DISTRICT OF COLUMBIA-MARYLAND-VIRGINIA,

U.S. Govt Printing Office, Washington, D. C., 1969. 3 vol, 1404 p.

Descriptors: *Conferences, *Interstate rivers, *Water pollution, Mathematical models, Population, Water supply, Tertiary treatment, Eutrophication.
Identifiers: *Potomac River.

This paper contains a verbatim transcript of the third session of the Federal Enforcement Conference held in April-May, 1969. Considered by the Conference are the following aspects: the improvements achieved since the last session; present and predicted future conditions in the area as regards population, economy, and water resources; the present state of water quality, including the sources and effects of various pollution discharges and the results of some surveys; research work, including the use of mathematical models and their verification; studies on eutrophication and methods for controlling algal growths, such methods being tertiary treatment or sewage effluent diversion; proposals and recommendations for further remedial action; and, the cost of necessary pollution-abatement measures.

103

SYSTEMS ANALYSIS FOR URBAN WATER MANAGEMENT,

Water Resources Engineer, Inc.

Completion Report: OWRR Project C-1536, Sep 1970. 78 p, 12 fig, 9 tab, 46 ref, 1 append.

Descriptors: *Systems analysis, *Water management (applied), *Simulation analysis, *Mathematical models, Storm runoff, Municipal water, Economics, Cities, Urbanization.

The major purpose of this study was to indicate that the goals of urban water management, with respect to the use and further development of systems analysis tools, are attainable. It was primarily a technical enterprise to demonstrate that a comprehensive model could be constructed in a general enough format to allow its application to many urban water systems while at the same time urban water subsystem submodels, comprising the larger model, could be operated independently to describe behavior of specific urban subsystems. Economic aspects were also considered. A comprehensive simulation model was developed for a specific hypothetical Urban Water Resources System structured to indicate the interrelationships among inflows, storage volumes, outflows, and qualities in various subsystems. A more expensive but more refined storm water modeling project was described. An economic systems model was formulated to evaluate physical works projects intended to meet urban water objectives subject to technical and budgetary constraints. Results of the hypothetical demonstrations of the technical and economic models were given. Major conclusions and recommendations were presented.

104

STORM WATER POLLUTION, NEW ORLEANS, LOUISIANA,

New Orleans Sewerage and Water Board, Louisiana

Supplementary Report, Jun 1970. 56 p, 52 fig. Repair work in conjunction with Community Renewal Program Project No La-R-6 (CR).

Descriptors: *Repairing, *Sewers, *Leakage, *Water pollution control, *Pollution abatement, *Drainage systems, *Storm drains, *Municipal wastes, *Sewerage, *Water quality control, Waste water treatment, Path of pollutants.
Identifiers: *Sewer repairs, *Storm water pollution, *Sewer inspection, *Sewer leakage, *New Orleans, Louisiana, Televised inspection.

The results were evaluated of sewer repairs that were made by the New Orleans Sewerage and Water Board to correct major leaks and defects found using television equipment. Field inspection work was conducted in 1969 to determine how and to what extent the storm waters discharged to Lake Pontchartrain are being polluted by domestic sewage. The results were published in a basic report having the same title as this supplementary report. Upon completion of the repairs of 47 major defects, exfiltration tests were made on the repaired lines. The results indicated excessive leakage still existing. Television photographs of pipe leakage and exfiltration data are included.

105
STORM WATER POLLUTION, NEW ORLEANS, LOUISIANA
New Orleans Sewerage and Water Board, Louisiana

Final Report, Jun 1970. 117 p, 19 fig, 49 tab, 14 ref. Community Renewal Extension Project No La-R-6 (CR).

Descriptors: *Pollutant identification, *Water pollution, *Path of pollutants, *Water pollution control, *Pollution abatement, *Storm drains, *Drainage systems, *Sewers, *Municipal wastes, *Sewerage, *Water quality control, Repairing, Design standards, Installation.
Identifiers: *Storm water pollution, *Sewer leakage, *Televised inspection, *Sewer inspection, *New Orleans, Louisiana.

The findings are presented of field inspections of the operating condition of sanitary sewers and storm sewers in New Orleans to determine how, and to what extent, the storm waters discharged to Lake Pontchartrain are being polluted by domestic sewage. Television cameras were pulled through sewers to view leakage into sewer pipes at open joints, fractures, and house connections. It was found that the major source of storm water pollution came from accidental cross flows between sanitary sewer house connections and storm sewers at points of crossings, particularly where house sewers cross beneath storm sewers. The fractures are attributed to the weight of the overlying storm sewer on the house connections beneath. Recommendations are given for the design and installation of sanitary sewers, house connections, and storm sewers. Explanation of field inspection procedures and television inspection data are included.

106
MERCER COUNTY, NEW JERSEY, COMPREHENSIVE PLAN: ANALYSIS OF WATER SUPPLY AND SEWERAGE FACILITIES OF MERCER COUNTY,
Mercer County Planning Board, Trenton, New Jersey

Final Rep, No 7, Nov 1969. 41 p, 7 tab, 2 map, 19 ref.

Descriptors: *Sewers, *Water resources, *Waste water (pollution), *Waste treatment, *Treatment facilities.
Identifiers: *Mercer County, New Jersey, *Regional planning.

Approximately 266,000 of Mercer County's 300,000 population is supplied with water from public or private water sources. The remainder receives its water from individual private wells. The source of water for 75 percent of the County is the Delaware River and the Water is supplied by the city of Trenton Water Company. The analysis indicates that the County has adequate water resources to handle expected future development. Most of Mercer County's population is serviced by modern wastewater collection and treatment facilities. For the remainder of the County, preliminary engineering reports and feasibility studies are being prepared by municipal officials and study groups to indicate how these areas can be serviced.

107

REPORT TO THE CITY OF FLINT, MICHIGAN ON SANITARY AND STORM SEWER SYSTEMS,
Metcalf and Eddy, Inc., Boston, Massachusetts

Report to Department of Public Works and Utilities, City of Flint, Michigan, Sep 12, 1969. 159 p, 11 fig, 12 tab, 11 ref.

Descriptors: *Sanitary engineering, *Sewers, *Sewerage, *Infiltration, *Drainage systems, *Urbanization, *Pollution abatement, *Storm runoff, *Water pollution control, Separation techniques, Sewage treatment, Treatment facilities, Future planning.
Identifiers: *Combined sewers, *Sanitary sewers, *Storm sewers, *Flint, Michigan.

The report describes the study procedures and presents the findings, conclusions, and recommendations of an engineering investigation of the adequacy of the sanitary sewer and storm sewer systems and the wastewater disposal facilities of the City of Flint. The sewer systems performed their present functions satisfactorily; however, major problems were: 1) basement flooding, 2) river pollution, and 3) potential flooding from future storm water discharges from adjoining townships. In addition to recommendations for system improvements and expansion of existing facilities, several far-reaching and unconventional recommendations were made. Special field investigations of surface and groundwater infiltration into existing sewers are also recommended. The need for cooperation between Flint and Genessee County is stressed, particularly for rainfall and runoff data collection and flood plain conservation.

108
MERCER COUNTY, NEW JERSEY, COMPREHENSIVE PLAN: STORM WATER RUNOFF AND DRAINAGE FACILITIES,
Mercer County Planning Board, Trenton, New Jersey

Final Report, Sep 1969. 30 p, 5 tab, 10 ref.

Descriptors: *New Jersey, *Drainage, *Runoff, Rainfall, Culverts, Surveys.
Identifiers: *Regional planning, *Storm water, *Mercer County, New Jersey.

Major problems occur in developing areas when open land which formerly absorbed rain water becomes covered with structures and asphalt. The county has a major responsibility in ensuring that, as land becomes developed and storm water runoffs increase, facilities guiding flows under county roads remain adequate to handle the increased water flow. The report analyzes each of the drainage areas adjacent to existing major county bridges or culverts to determine whether they will be adequate to handle increased flows when the drainage areas develop as presently zoned.

109
STORM DRAINAGE IN THE TOLEDO REGIONAL AREA,
Toledo Regional Area Plan for Action, Ohio

Regional Report 9.3, Office of the Lucas County Engineer, Sep 1969. 118 p.

Descriptors: *Storm drains, *Drainage systems, Urbanization, Floods, Sanitary engineering, Standards.
Identifiers: *Storm sewers, *Toledo, Ohio, Combined sewers.

The report is an inventory and analysis of existing storm drainage systems. The collected information provides a basis for solving immediate drainage problems, guiding new development to those areas amenable to good drainage, and planning for future drainage improvements. Subject areas covered by the study include: planning and financing of storm drainage facilities, general standards for storm drainage systems, mapping for watershed areas, and computation of storm water runoff and water surface elevations. Two important problem areas examined are flooding and combined sewers.

110
FLOOD PLAIN INFORMATION, CITY OF ALEXANDRIA AND ARLINGTON COUNTY, VIRGINIA, FOURMILE RUN,
Corps of Engrs, Baltimore, Maryland

Report, Oct 1968. 38 p, 11 fig, 7 tab.

Descriptors: *Flood forecasting, *Flood plains, *Flood damage, *Storm runoff, *Urbanization, Planning, Runoff, Flood control, Drainage, Regional flood.
Identifiers: *Fourmile Run, Virginia, *Arlington County, Virginia, *Alexandria, Virginia, *Arlandria, Virginia.

Flooding was studied on the lower 3 miles of Fourmile Run, a floodway draining 18.5 square miles that flows 9 miles through Arlington County, along the northern boundary of Alexandria, Virginia, and discharges into the Potomac River downstream of Washington National Airport. During the largest flood of record, in August 1963, damage to business properties in a four-block stretch of Arlandria was estimated at more than one million dollars. Two significant phases are covered of the Fourmile Run flood problem: (1) the largest known floods, and (2) probable future floods. Estimates are made of the maximum velocities, discharge rates, and flood depths that would result from a flood having a 100 year average recurrence interval, and from the maximum probable flood that could ever be anticipated in the area. This latter flood would top the flood depth of record by 10.3 feet on Mount Vernon Avenue in Arlandria, and discharge 25,000 cfs at its peak. The report is intended to provide the basis for further study and planning by Arlington County and Alexandria to develop solutions. The report contains maps, profiles and cross-sections that indicate the extent of future flooding anticipated. These can be used to guide and plan land developments, and to formulate zoning ordinances and subdivision regulations. They can also be used in planning flood protection works.

111
REPORT ON FOURMILE RUN FLOODING, ALEXANDRIA, VIRGINIA,
Greeley and Hansen, Chicago, Illinois

Report to City of Alexandria, Virginia, Apr 1968. 66 p, 14 fig, 5 tab.

Descriptors: *Flood protection, *Flood control, *Storm runoff, *Urbanization, *Drainage engineering, Construction costs, Runoff, Planning.
Identifiers: *Fourmile Run, Virginia, *Arlington County, Virginia, *Alexandria, Virginia, *Arlandria, Virginia.

General design criteria are developed along with a basis of design for the construction of engineering works to protect property from flooding along Fourmile Run between the stream's outlet to the Potomac River and the Shirley Highway. Fourmile Run carries storm water runoff from an 18.5 square mile drainage area in Arlington County. Extensive damage to commercial and residential properties results from flash floods, particularly in the Arlandria area at the North boundary of the City of Alexandria. The data obtained on the maximum flood of record, August 20, 1963, were considered in the study. The recommended basis of design is to provide for a minimum discharge of 20,000 cfs, but, preferably, 24,000 cfs. The construction costs for the latter are estimated at $9,437,000, based on 1968 unit costs. The project would entail: the removal and construction of new culverts, bridges and a railroad trestle which constitute streamflow bottlenecks; provision of storage in the main stem by channel improvement and levee construction; off-channel detention storage on City-owned property located in the flood zone; and miscellaneous provisions, including possible removal of buildings from the flood plain. The Fourmile Run flash flooding problem is a prime example of similar situations in various parts of the country.

112
IMPACT-TYPE ENERGY DISSIPATOR FOR STORM-DRAINAGE OUTFALLS STILLING WELL DESIGN,
Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Technical Rep, No 2-620, Mar 1963. 66 p, 9 tab, 37 plates.

Descriptors: *Drainage, *Storms, *Underground structures, *Erosion, Pipes, Design, Flow, Stilling basins.
Identifiers: *Energy dissipator.

An impact-type energy dissipator consisting of a vertical section of circular pipe affixed to the outlet end of a storm drainage outfall, termed a stilling well, was studied in the laboratory to determine the energy loss coefficient and the effects of the geometrical components of such a structure. The results were generalized and given in terms of dimensionless parameters. Investigations were conducted with a 0.99-ft-diameter model stilling well which had a 2-ft-diameter

Report to City of Alexandria, Virginia, Apr 1968. 66 p, 14 fig, 5 tab.

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113
AREAWIDE WATER AND SEWER PLAN, COMPREHENSIVE PLANNING STUDY, HARRISON, ARKANSAS,
Harrison City Planning Commission, Arkansas

Jun 1970. 27 p.

Descriptors: *Sewers, *Urbanization, *Project planning, Water supply, Sewage treatment.
Identifiers: *Storm sewers, Harrison, Arkansas.

This water and sewer study is based on earlier volumes of a comprehensive plan concerning public utility improvement projects in a specific planning area.

114
STORM DRAINAGE FACILITIES, UNION COUNTY, NEW JERSEY,
Union County Planning Board, N. J.

May 1970. 97 p.

Descriptors: *Floods, *New Jersey, Drainage, Storms, Design, Storage.
Identifiers: *Union County, New Jersey, *Storm sewers.

The report presents an inventory and analysis of the storm drainage facilities of Union County, New Jersey. Points of analysis were generally selected where streams cross major County throughfares. The tributary area to each of these points was determined. Estimates of minimum design flows were prepared. These suggested minimum design flows were then used to determine the adequacy of the existing drainage facility at the point of analysis.

115
STORM DRAINAGE FACILITIES, UNION COUNTY, NEW JERSEY,
Union County Planning Board, New Jersey

May 1970. Various pagings.

Descriptors: *Management, *Planning, New Jersey, Floods, Drainage, Storms, Structures, Rainfall, Design, Roads, Maps.
Identifiers: *Storm sewers, *Union County, New Jersey.

The report presents an inventory and analysis of the storm drainage facilities of Union County, New Jersey. Points of analysis were generally selected where streams cross major County thoroughfares. The tributary areas to each of these points were determined. Estimates of minimum design flows were prepared. These suggested minimum design flows were then used to determine the adequacy of the existing drainage facility at the point of analysis. The second stage of this report will analyze tidal influence upon storm drainage facilities and present a recommended plan of improvements.

116
RECOMMENDED REGIONAL PLAN FOR SEWERAGE, WATER SUPPLY AND STORM DRAINAGE,
Valley Regional Planning Agency, Ansonia, Conn.

Feb 1970. 92 p.

Descriptors: *Urban planning, *Connecticut, Drainage, Floods, Control.
Identifiers: *Storm sewers, Water resources.

The report presents the recommended regional plan and program for sewerage, water supply, and storm drainage for the 58 square mile Valley Planning Region, comprising Ansonia, Derby, Seymour, and Shelton, Connecticut.

117
STORM DRAINAGE: INVENTORY AND ANALYSIS OF MAJOR EXISTING AND PLANNED FACILITIES; VOLUME V,
Valley Regional Planning Agency, Ansonia, Conn.

Feb 1970. 38 p.

Descriptors: *Urban planning, *Connecticut, *Sewers, Drainage, Floods, Sewage, Storm drains.

The fifth of a five-volume report that is being utilized as part of the basis for an areawide water/sewer plan and program for the Valley Region is detailed herein. This volume includes an inventory and evaluation of the major existing and planned facilities. The inventory includes a delineation of present areas served by storm sewers and areas requiring flood protection.

118
TECHNICAL COMMITTEE ON STORM OVERFLOWS AND THE DISPOSAL OF STORM SEWAGE: FINAL REPORT,
Ministry of Housing and Local Government, England

1970. 76 p, 2 append.

Descriptors: *Publications, *Storm runoff, *Sewage disposal, *Sewers, *Investigations, Surveys, On-site investigations, Structures, Model studies.
Identifiers: *Great Britain, *Storm overflows.

This is the final report of the Technical Committee on Storm Overflows and the Disposal of Storm Sewage appointed on May 20, 1955 whose purpose it was to "study and report upon practices relating to storm overflows on sewers and the disposal of storm water and to make recommendations". An extensive program of experimental and special studies have been conducted and are reported herein under individual chapter headings. Chapters are abstracted separately and follow below.

119
TECHNICAL COMMITTEE ON STORM OVERFLOWS AND THE DISPOSAL OF STORM SEWAGE: CHAPTER 1. INTRODUCTION,
Ministry of Housing and Local Government, England

pp 1-4, 1970. 2 ref.

Descriptors: *Publications, *Investigations, Flow rates, Model studies, On-site investigations, Storm runoff, Overflow.
Identifiers: *Great Britain, *Historical review, Storm overflows, Storm tanks.

The historical evolution of the sewerage system in England and Wales is outlined. Until 1955 requirements for design practices of sewer systems, treatment measures, and the construction of storm overflows were based on 1898 report conclusions. Since 1955, investigations have been initiated by the Technical Committee in the following areas: 1) a survey of storm overflows in 52 local authority areas to obtain information about the numbers and types of overflows in existence and the local circumstances in which they operated; 2) an investigation of the rate of flow and composition of storm sewage in three drainage areas; 3) experiments on small-scale models of different types of overflows to compare their performance and assess the value of storage under the time-varying flow of storm conditions; 4) field-scale experiments on different types of overflows, to test their hydraulic efficiency and also their efficiency in limiting the amount of pollution discharged by the overflows; and 5) an investigation of the performance of storm tanks. (See abstract number 117.)

120
TECHNICAL COMMITTEE ON STORM OVERFLOWS AND THE DISPOSAL OF STORM SEWAGE: CHAPTER 2. EXTENT OF THE PROBLEM,
Ministry of Housing and Local Government, England

pp 5-9, 1970. 2 fig, 2 tab, 1 ref.

Descriptors: *Publications, *Surveys, Surface waters, Water pollution sources.
Identifiers: *Great Britain, *Storm overflows.

Storm overflows occur in all combined and partially-separated sewer systems. Only 8% of the authorities covered (226 works) by the survey have completely separate sewerage systems. Pollutional problems arise from some surface runoff yet it is recommended that surface water runoff be connected to sewers only when runoff is heavily polluted. It is further recommended that re-sewering be done on a separate system basis as the need and funds arise. A storm overflow questionnaire was completed by authorities representing 3.6% of all local areas serving 8.2% of the total population on main drainage. Of the 849 overflows surveyed, 317 were considered unsatisfactory for the following various reasons: stranding of solids in vicinity of watercourse, effect on biology, operation in dry weather, too frequent operation in wet weather, combined influence with neighboring overflows, and deposits of sludge in the watercourse. (See abstract number 117.)

121
TECHNICAL COMMITTEE ON STORM OVERFLOWS AND THE DISPOSAL OF STORM SEWAGE: CHAPTER 3. FIELD STUDIES ON FLOW AND COMPOSITION OF STORM SEWAGE,
Ministry of Housing and Local Government, England

pp 10-35, 1970. 12 fig, 15 tab, 3 ref.

Descriptors: *Publications, *On-site investigations, *Rainfall, *Storm runoff, *Sewage, Flow measurement, Overflow, Flow rates.
Identifiers: *Great Britain, *Sewage composition.

A program of field studies was undertaken by the Water Pollution Research Laboratory at Northampton, Brighouse, and Bradford in order to collect information on the flow and composition of storm sewage. At each site records of rainfall and the composition of storm sewage were maintained and the composition of dry-weather sewage was measured on a number of occasions during the following test periods: February 1960 to January 1962 at Northampton, from November 1958 to December 1961 at Brighouse, and from February 1961 to January 1964 at Bradford. Results from flow measurements at Northampton and Brighouse may be useful in predicting the annual duration and volume of discharge from hydraulically efficient overflows in other areas. Further, it was found that storm sewage was weakest during the night, although there was less diurnal variation than observed in the dry-weather sewage; its strength decreased with time during storms, and to some extent depended upon the flow. Although there were wide variations in the composition of storm sewage from site to site and from time to time, a rough estimate of the average strength of storm sewage found in these areas is 400 mg/l suspended solids, 40 mg/l permanganate value, 80 mg/l BOD, and 4 mg/l ammoniacal nitrogen. (See abstract number 117.)

122
TECHNICAL COMMITTEE ON STORM OVERFLOWS AND THE DISPOSAL OF STORM SEWAGE: CHAPTER 4. LABORATORY EXPERIMENTS OF MODELS OF STORM OVERFLOWS,
Ministry of Housing and Local Government, England

pp 36-42, 1970. 4 fig, 2 tab, 2 ref.

Descriptors: *Publications, *Laboratory tests, *Model studies, Analysis.
Identifiers: *Great Britain, *Storm overflows, *Comparative performance.

The main purpose of the laboratory experiments was to compare the effectiveness of four types of overflows with non-steady polluting discharges and to assess the extent to which storage of a first flush of heavily polluting storm sewage might be beneficial. The overflows studied were a low side-weir, a stilling pond, a vortex with spill over a central ring weir, and an overflow with storage beyond high side-weirs. A summary of performance with polluting material according to A (gradient 1 to 500) and B (gradient 1 to 100) shows that:

low side-weir -- (A) worst of the four with grit and coarse solids yet good retention of floating solids with scumboards, and (B) best retention of floating solids with scum-boards and moderate performance with dissolved pollution, coarse solids, and grit; stilling pond -- (A) best of the four with coarse solids and grit and good retention of floating solids with scum-boards, and (B) moderate performance with all pollutants; vortex with central weir -- (A) moderate other than poor retention of floating solids, and (B) worst of the four with dissolved pollution and similar to the spilling pond for others; and storage type -- (A) best of the four with dissolved pollution and best retention of floating solids with or without scum-boards, and (B) moderately good with dissolved pollution yet best of the four with coarse solids and best retention of floating solids without scum-boards. (See abstract number 117.)

123
TECHNICAL COMMITTEE ON STORM OVERFLOWS AND THE DISPOSAL OF STORM SEWAGE: CHAPTER 5. FIELD-SCALE EXPERIMENTS ON STORM OVERFLOWS,
Ministry of Housing and Local Government, England

pp 43-50, 1970. 3 fig, 1 tab, 2 plate, 2 ref.

Descriptors: *Publications, *On-site investigations.
Identifiers: *Great Britain, *Storm overflows, *Comparative performance.

This chapter describes experiments involving the steady flow of crude sewage at various rates in storm overflow structures at the East Hyde Sewage Treatment Works of the Luton Corporation. The following results were determined: 1) the low side-weir was shown to be inefficient as a device for accurate hydraulic separation, spilling prematurely and lacking control at high flows; 2) the stilling pond with orifice control was satisfactory in its control of flow to treatment, yet currents set up in the fan-shaped chamber were not conducive to efficient settlement of solids; 3) the vortex with orifice control was reasonably satisfactory in its control of flow to treatment, and its performance in retaining gross solids was poor except at high flows; and 4) the high-weir with orifice control was comparable to the stilling pond in hydraulic performance, and had the best performance of all the overflows tested (with scum-boards) in retaining gross solids and faeces. A comparison of tests on laboratory scale and on field scale is included. (See abstract number 117.)

124
TECHNICAL COMMITTEE ON STORM OVERFLOWS AND THE DISPOSAL OF STORM SEWAGE: CHAPTER 6. THE SETTING OF STORM OVERFLOWS,
Ministry of Housing and Local Government, England

pp 51-58, 1970. 2 ref.

Descriptors: *Publications, *Mathematical studies.
Identifiers: *Great Britain, *Storm overflows, *Overflow setting.

Various formulae have been considered which attempt to achieve the aims of raising the average setting and making appropriate allowance for water usage variations, infiltration, and industrial effluents. None of these formulae can possibly be precise in the sense that its application could control the amount or quality of overflow accurately to predetermined levels. Furthermore, none is likely to be fully applicable to areas with very long times of concentration. Favored by the Committee is Formula A which is the simplest and whose scope is restricted to achieving a modest improvement on present practice and to making a more appropriate allowance for variations in water usage, infiltration and industrial flow. Formula A is: setting (Q) = DWF + 300 P + 2E g.p.d. where DWF is the dry-weather flow in gallons/day; P is the population of these areas; and, E is the volume of industrial effluent in gallons discharged in a 24-hour period. (See abstract number 117.)

125

TECHNICAL COMMITTEE ON STORM OVERFLOWS AND THE DISPOSAL OF STORM SEWAGE: CHAPTER 7. STORM OVERFLOW STRUCTURES,
Ministry of Housing and Local Government, England

pp 59-62, 1970. 1 tab.

Descriptors: *Publications, *Design criteria, *Structural analysis, *Structural engineering, *Structures.
Identifiers: *Great Britain, *Storm overflows.

In the design of storm overflow structures, the following aspects should be considered and hopefully achieved: 1) it should not come into operation until the prescribed flow is being passed to treatment; 2) the flow to treatment should not increase significantly as the amount of overflowed storm sewage increases; 3) the maximum amount of polluting material should be passed to treatment; 4) the design should avoid any complication likely to lead to unreliable performance; 5) the chamber should be so designed as to minimize turbulence and risk blockage, it should be self-cleansing and require the minimum of attendance and maintenance. The two most significant factors affecting the design of overflow structures are hydraulic limitations and the handling of the wide variety of solid matter liable to be present in sewage. These aspects are discussed in relation to overflows in current use and overflows with downstream storage. (See abstract number 117.)

126
TECHNICAL COMMITTEE ON STORM OVERFLOWS AND THE DISPOSAL OF STORM SEWAGE: CHAPTER 8. STORM TANKS,
Ministry of Housing and Local Government, England

pp 63-68, 1970. 8 tab.

Descriptors: *Publications, *On-site investigations, *Analysis, Operations, Design criteria.
Identifiers: *Great Britain, *Storm tanks.

This chapter describes the main investigations in a study of storm tanks conducted at the Northern Sewage Works of the Borough of Royal Tunbridge Wells and at the Blithe Valley Sewage Works of the City of Stoke-on-Trent. The objective was to obtain records for most of the storm occurrences over a period of about two years. Among the information recorded for each storm was the time when flow into the tanks started and stopped, the state of the tanks at commencement of inflow, the time when flow out of the tanks to the stream started and stopped, and the contents of any tanks partly filled at the end of the storm. Results of the investigations were tabulated according to sewage strength, BOD sampling ranges, flow rates, purification, storage capacity, polluting load discharge, and retention periods. Design considerations and storm tank operation are included. (See abstract number 117.)

127
TECHNICAL COMMITTEE ON STORM OVERFLOWS AND THE DISPOSAL OF STORM SEWAGE: CHAPTER 9. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS,
Ministry of Housing and Local Government, England

pp 69-73, 1970.

Descriptors: *Publications.
Identifiers: *Storm overflows, *Summary, Great Britain.

Each chapter of the Final Report is summarized briefly. It is concluded by the Committee that there are generally too many storm overflows and that sewerage authorities could examine their systems with a view to using overflows and sewer capacity to the optimum extent. Other conclusions and recommendations which are described in detail in individual chapters are reiterated. The Committee recommends the following areas for future research: 1) the effect of intermittent discharges of storm sewage on streams; 2) storage and control of gross solids discharge; and 3) information on storm tank operation. (See abstract number 117.)

128

WATER SUPPLY AND SEWAGE DISPOSAL,

Rensselaer County Dept of Planning and Promotion, Troy, New York
1968. 128 p.

Descriptors: *Water supply, *Sewage disposal, Costs, Analysis, Drainage, Storms, Sewers.
Identifiers: *Rensselaer County, New York.

These facilities have been separately examined but are included in a single report. The section of water supply consists of a basic inventory of the existing water systems, their capacity, the number of people served, and the per capita consumption. Also presented is a cost analysis for each community serviced. The section on sewers and stormwater facilities, and explanations of the districts proposed by the County, one of the towns, and by three of the villages. Appropriate maps and cost estimates for the new districts are also included.

129

POLLUTION STINK FOULS CITY HALL,

K. W. Bennett
Iron Age, Vol 206, No 7, pp 73-75, Aug 13, 1970.

Descriptors: *Legislation, *Water pollution control, *Water quality control, *Industries, *Cities.
Identifiers: *Law enforcement, *Viewpoint.

Although legislation has been passed concerning water pollution control in relation to industries and municipalities, enforcement of these laws has been directed more towards industrial control. However, the number of states taking action against cities which are pollution violators is on the rise. The author views the economic plight which the city faces and gives some examples of pollution abatement programs and treatment facilities under construction in cities across the United States.

130

FINAL REPORT OF THE TECHNICAL COMMITTEE ON STORM OVERFLOWS AND THE DISPOSAL OF STORM SEWAGE,

J. T. Calvert
Inst Civil Engrs (London), Vol 47, pp 305-308, Oct 1970.

Descriptors: *Sewage disposal, Costs, Water pollution sources, Sewers.
Identifiers: *Storm overflows, Great Britain.

An informal discussion on the Committee's findings shows that: 1) the abolition of all storm overflows was not recommended because the enormous cost could not be justified and pollution from surface water sewers could still occur; and 2) a new formula, in which the amount of sewage to be contained in the system downstream of the overflow would vary only slightly with water consumption and the formula would broadly ensure that the polluting matter from each person was diluted by a fixed amount of rainwater before spill commenced, were recommended.

131

EFFECT OF SEASONAL EFFLUENT CHLORINATION ON COLIFORMS IN JAMAICA BAY,

R. T. Dewling, I. Seidenberg, and J. Kingery
J Water Pollution Control Fed, Vol 42, No 7, pp 1351-1361, Jul 1970.

Descriptors: *Investigations, *Chlorination, *Effluents, *Water pollution sources, *Water quality, *Data collections, *Coliforms, Analytical techniques, Overflow, Discharge measurement.
Identifiers: *Jamaica Bay, New York, Storm overflows, Combined sewers.

This article is a report on a study conducted to demonstrate that chlorination of wastewater treatment plant effluents would significantly improve the bacteriological quality of Jamaica Bay. A description of the investigation procedure, the Bay area, and its water uses and pollutants is given; water quality data collection analysis is detailed. The average daily discharge from storm and combined sewer overflows was calculated at about 34 million gallons based on a storm occurring at a frequency of about once every three days.

132

THE OPTIMIZATION OF STORM-HOLDING TANKS: A PROBLEM OF WATER POLLUTION CONTROL,

Charles Albert Kohlhaas
Dissertation, Feb 1970. 321 p.

Descriptors: *Optimization, *Storm drains, *Economics, Mathematical models, Chlorination, Infiltration.
Identifiers: *Storm sewage, *Combined sewers, Effluent tax, San Francisco Bay.

A literature review of the hydrology, quality, effect on the environment, and control technology of combined sewer overflows and overflows from sewers subject to heavy infiltration is made.

An analysis of water pollution externalities and remedies for dealing with them, including the use of effluent tax in particular, is given. The relationship between the pollution caused by storm-sewage overflow and competing urban needs is investigated. Two mathematical programs for optimizing control facilities from storm-sewage overflows are defined: one achieves economic efficiency by means of the effluent tax, the other incorporates water quality goals by means of stream standards. The stream standards program is applied to a practical problem of storm-sewage overflow in East San Francisco Bay, California. Water quality regulations for controlling overflows are formulated and treatment processes based on the use of holding tanks are defined. The effect of a holding tank on input discharge, BOD, and coliform concentrations is described. Graphs relating BOD load and average coliform concentration of holding tank effluent to tank capacity are employed to size holding tanks capable of meeting effluent standards. The mathematical program is solved as a separate non-linear program. Detention times needed to satisfy BOD limitations were more than adequate to meet limitations on coliform concentrations. For most cities the high cost of solutions to storm-sewage overflow problems will prevent the implementation of control measures in the near future. An effluent tax may be used as a means of financing alternative recreation and as an incentive for implementation of control measures. Requirements concerning maximum coliform concentrations are best met by limitations on the minimum size of holding tanks. Optimization models capable of incorporating an almost infinite number of holding tanks and over 2,000 water quality requirements may be constructed.

133

THE OPTIMIZATION OF STORM HOLDING TANKS: A PROBLEM OF WATER POLLUTION CONTROL,

Charles Albert Kohlhaas
Stanford University Thesis, 1970. 337 p.

Descriptors: *Water pollution, *Water pollution control, *Water pollution sources, *Storm runoff, *Reviews, *Overflow, *Infiltration, *Sewers, *Storage tanks, Costs, Water quality, Water quality control, Hydrology, Environmental effects, Control systems, Standards, Mathematical models, Biochemical oxygen demand.
Identifiers: *Combined sewers, *Storm sewage, *Effluent tax, Treatment methods, Stream standards.

A literature review of the hydrology, effect on the environment, and control technology of combined sewer overflows and overflows from sewers subject to heavy infiltration is made. An analysis of water pollution externalities and remedies for dealing with them, including the use of the effluent tax, is given. The relationship between the pollution caused by storm-sewage overflows and competing urban needs is investigated. Two mathematical programs for optimizing control facilities for storm-sewage overflows are defined wherein one achieves economic efficiency by means of the effluent tax, and the other incorporates water quality goals by means of stream standards. The stream standards program is applied to a practical problem of storm-sewage overflow in East San Francisco Bay, California. Water quality regulations for controlling overflows are formulated. Treatment processes based on the use of holding tanks are defined. The effect of a holding tank on input discharge, BOD, and coliform concentrations is described by means of equations. The mathematical program is solved as a separable non-linear program. The cost of meeting different levels of water quality is investigated by changing the allowable amount of BOD that may be present at a given critical reach in the watercourse. Suggestions for future research are given.

134
RESEARCH ON USES AND ON WATER TREATMENT,

R. I. Odell
Brewing Trade Review, Vol 85, No 1014, pp 43-46, Jan 1971.

Descriptors: *Research and development, *Water storage, *Water reuse, *Water distribution (applied), *Waste water treatment, *Runoff, *Desalination.
Identifiers: *Great Britain, *Information exchange.

This report briefly discusses the following aspects of water supply and demand in England and Wales: (1) underground water storage, (2) runoff use, (3) desalination, (4) treatment methods and standards, (5) water distribution, (6) water wastage, (7) the economics of water resource development, and (8) information exchange in the field of water supply.

135

A SUMMARY OF THE HOPKINS STORM DRAINAGE RESEARCH PROJECT: ITS OBJECTIVES, ITS ACCOMPLISHMENTS, AND ITS RELATION TO FUTURE PROBLEMS IN URBAN HYDROLOGY,

John C. Schaake
In: The Progress of Hydrology, Vol 2 - Specialized Hydrologic Subjects, Proceedings 1st International Seminar for Hydrology Professors, Jul 13-25, 1969. 28 p, 8 fig, 12 ref.

Descriptors: *International hydrological decade, *Urbanization, *Rainfall-runoff relationships, Research and development, Rational formula, Engineering, Hydrology, Hydraulics, Storm runoff, Model studies.
Identifiers: *Water resources research, *Urban hydrology.

Since its initiation in 1949, the Hopkins Storm Drainage Research Project had the following primary objectives: development of the principles of hydraulic behavior of storm water inlets and the practical application of these principles to storm water inlet design practice; development of instruments for measuring and recording rainfall and storm runoff and the systematic collection of rainfall-runoff data; and development of the relationship between rainfall and runoff and application to storm sewer design practice. During the period 1949 to 1967, 52 locations were gaged. Some of these involved only a rainfall measurement, but 40 locations involved both rainfall and runoff gages. Some of the gaged catchments were sewered, but 29 of them were inlet areas. A computer model of the rainfall-runoff process was developed to predict runoff more accurately than any other method; it is based on sound physical principles, and runoff data are not required for its application.

136

STORM WATER FOR FUN AND PROFIT,

John R. Sheaffer
Water Spectrum, Vol 2, No 3, pp 29-34, Fall 1970. 7 fig, 1 tab.

Descriptors: *Storm runoff, *Planning, *Environmental engineering, *Multiple-purpose projects, *Benefits, *Water supply, *Recreation, *Flood protection, Retention.
Identifiers: *Storm water, *Potential resources.

A conceptual framework for storm water management is presented illustrating in several case studies opportunities to capitalize upon a wide range of benefits. The three basic principles in the framework are: (1) the environment is a single unit with air, land, water, and urban development interacting; (2) the earth for planning purposes is a closed system; (3) storm water is a potential resource out of place. The unity of the environment places storm water in a comprehensive perspective. Interchanges between surface and groundwaters and effects of urban land uses on distribution and quality must be recognized so that external costs will not affect drainage benefits. Considered within a closed system, the problem becomes one of space allocation. And viewed as a resource, location becomes an important factor. It is simply improper location that makes storm water a problem. When viewing storm water as a resource, quality must be carefully considered, particularly the initial flush which has been shown to be highly polluted. Therefore, a distinction must be made between detention and retention reservoir. When storm water is to be retained, it must be in an unpolluted condition or given treatment before storage. The six case studies discussed are: storm water management at the Flick-Reedy plant in Bensensville, Illinois; Leetsdale-Oneida Apartment development at Denver; Howard Gulch flood control project in Denver; skyline urban renewal project in Denver; Marcy Forest View Apartment development in Arlington Heights, Illinois; and the Indian Lakes storm drainage design in Bloomingdale, Illinois. All six cases illustrate in varying degrees the synergistic benefits of water supply, flood damage reduction, recreation, and open space.

137

SEWERS AND SEWAGE TREATMENT,

James R. Simpson and R. L. Hibberd
Proc Symp: Farm Wastes: The Institute of Water Pollution Control and The University of Newcastle-upon-Tyne, Paper No 7, pp 44-51, 1970. 2 fig, 2 tab, 13 ref.

Descriptors: *Costs, *Design criteria, *Sewage treatment, Farm wastes, Biochemical oxygen demand, Legislation, Dissolved solids, Tertiary treatment, Sewers, Activated sludge, Capital costs.
Identifiers: River authority, Loading rates, Mogden formula, Great Britain, Population equivalents, Suspended solids.

The purpose of this paper is to acquaint those unfamiliar with sewerage and sewage treatment with the general nature of the systems and processes. An attempt is made to answer the questions, "Why and to what extent would a discharge with given characteristics affect the design of the sewers and the sewage-treatment works, and at what cost." A formula for allocating waste treatment cost to agriculture is discussed. A discussion of the paper is included.

138

PHYSIOCHEMICAL AND MICROBIOLOGICAL PROPERTIES OF URBAN STORM WATER RUNOFF,

G. Soderlund, H. Lehtinen, and S. Friberg
Fifth International Water Pollution Research Conference, San Francisco, Jul 26-Aug 1, 1970. Preprint Paper I-2. 8 p, 18 fig.

Descriptors: *Storm runoff, *Chemical properties, *Microbiology, Sampling, Nitrogen, Phosphorus, Water pollution effects, Snowmelt.
Identifiers: Urban runoff, Lead, Suspended solids, Sweden.

In Sweden today a separation of storm and sanitary sewers is usually preferred. This avoids the discharging of mixed storm water and wastewater into the streams and inland waters. There is an increasing discussion as to whether the direct discharge of storm water into streams can be justified for the future. A study to collect more information concerning the nature and extent of the pollutional load from highly urbanized areas was made. The results of this study showed that the discharging of snowmelt from heavily trafficed areas into streams and inland waters contributes in a great extent to the pollution of the recipients with oil and heavy metals. Traffic roads give a high degree of contamination as compared with the other test areas. The oil in the storm water is contaminated with oil not only from the traffic but also from the industrial areas. As the use of cutting oils and emulsions, dry cleaning liquids, and industrial cleaning liquids increases the problem of collection and destroying such waste liquids must be solved. Various measurements were taken in areas differing with respect to traffic intensity. The analytical values obtained represent a skewed distribution. Nearly 50% of the dry residue obtained from warm water runoff is volatile material, most probably asphalt from the roadway and rubber from tires and oil. Other constituents measured in concentration versus time were chloride, pH, nitrogen, phosphorus, coliforms, carbohydrates, and BOD.

SECTION 7.

Legislation and Standards

139
CLEVELAND FACES POLLUTION SUIT,

Chemical Week, Vol 107, No 9, p 18, Aug 26, 1970.

Descriptors: *Legal aspects, *Water pollution sources, *Water pollution control, Lake Erie, Treatment facilities, City planning, Contracts, Sewers.
Identifiers: *Cleveland, Ohio.

The Ohio Water Pollution Control Board has directed Attorney General Paul Brown to file suit against Cleveland for failure in meeting a June 15, 1970 deadline to install temporary chlorination facilities in its sewage treatment plants which pollute Lake Erie. The city also failed to meet a July 1st deadline to contract for sanitary interceptor sewer plans in various parts of the city.

140
ESTABLISHMENT AND OPERATION OF METROPOLITAN SEWERAGE COMMISSIONS,

8 Wis Stat Ann sec 59.96 (1957) as amended (Supp 1970).

Descriptors: *Wisconsin, *Cities, *Administrative agencies, *Sewage districts, Sewers, Water supply, Potable water, Sewage treatment, Legislation, Water pollution, Legal aspects.

In counties with more than 500,000 population, which have passed resolutions declaring the need for sewage disposal works, and which have qualified and appointed sewerage commissions, this Wisconsin legislation provides for appointment of sewerage commissioners. Metropolitan sewerage commissions may by resolution add to their district other areas within their county where such areas drain or may drain sewage into water which is or may be used as a source of drinking water. Procedures are outlined for adding such areas. The sewerage commissions have the power and duty to plan and construct sewers, pumping, and temporary disposal works for the collection and transmission of various types of sewage. Commissions may improve watercourses and divert water as long as they comply with procedures outlined in the statute. Commissions may promulgate rules and regulations for the operation of their systems and may acquire land needed to implement systems. Except as allowed by the statute, the commissions' power shall not extend to first class cities implementing their own sewerage system. Financing of improvements and tax levying procedures are also outlined.

141
CHELTENHAM AND ABINGTON SEWERAGE CO V PUBLIC SERVICE COMMISSION (DEDICATION OF SEWERAGE SYSTEM),

162 A 469-473 (Pa 1932).

Descriptors: *Pennsylvania, *Sewers, *Rates, Drainage systems, Sewage disposal, Easements, Urbanization, Administrative agencies, Administrative decisions, Land tenure.
Identifiers: *Storm sewers.

Plaintiff sewerage company appealed an order of defendant public service commission abolishing plaintiff's charges for sewerage systems in two townships. The sewerage systems of the townships were installed by a promoter along with surface drainage improvements. The promoter formed plaintiff corporation, but did not convey his rights in the system to plaintiff until after the sale of a number of lots in certain subdivisions. The promoter's conveyances to the lot owners did not deserve any rights to the sewerage system. No charges for the storm sewers had been made for 30 years. Defendant contended that these circumstances proclaimed the promoter's intent to dedicate the sewerage system to the public, and hence plaintiff did not own the system. Sustaining this contention, the court noted that the residents had a drainage easement wherever the promoter had installed drains in natural watercourses and held that plaintiff could not extract charges for the system. Plaintiff further contended that one of its employees cleaned the system after heavy rains three or four times a year, but the court held that this service did not justify compensation. Defendant's order was affirmed.

142
HALE VERSUS KANSAS CITY, MO (CITY'S LIABILITY FOR FLOOD DAMAGE CAUSED BY FAILURE TO OPEN FLOODGATE DURING RAINSTORM),

187 SW2d 31-41 (Mo Ct App 1945)

Descriptors: *Flood damage, *Storm drains, *Flood gates, Settlement (structural), Runoff, Water injury, Judicial decisions, Sewers, Cities, Backwater, Flood control, Drainage systems.
Identifiers: *Kansas City, Missouri.

Plaintiff paper bag company brought action against defendant city for flood damage to plaintiff's building caused by defendant's failure to open the sewer system's main floodgate during a heavy rainstorm. Plaintiff contended that no flooding would have occurred if defendant had opened the main storm drain and operated its drainage pumps. Defendant argued that submission of plaintiff's contention to the jury was improper since the purpose of the floodgate was not to facilitate the sewage system's flow, but to prevent water from the river from backing up into the sewer system during high water. Affirming a judgment for plaintiff, the court held that regardless of the primary purpose of the floodgate, the jury properly heard and decided the question of whether defendant's failure to open the gate during the rainstorm was the proximate cause of the damage to plaintiff's building.

143
FREEMAN V CITY OF LAKEMILLS (LIABILITY FOR INJURY CAUSED BY NATURAL PROCESSES),

243 Wis 537, 11 NW2nd 181-182 (1943).

Descriptors: *Wisconsin, *Natural flow, *Channel morphology, *Storm runoff, Storm drains, Surface water, Sewers, Creeks, Seepage, Legal aspects, Drainage practices, Relative rights, Flooding, Overflow.

Plaintiff landowner brought action to abate an alleged nuisance and for damages for injury to his property. Plaintiff contended that seepage into his basement was caused by the overflow of a natural watercourse adjacent to his property into which flowed surface water from defendant city's storm sewers. Plaintiff contended further that such action by defendant caused refuse deposition in the creek and caused the bed of the creek to be raised, and that the channel change which resulted from the raising of the bed caused the overflow. Defendant admitted only that it had used the creek for an outlet for its storm water, and contended that the evidence did not support the trial court's judgment for plaintiff. The Supreme Court of Wisconsin held that a city has the same right with reference to surface waters as an individual would have. Cities are not liable to riparian owners for material and water that flows from their streets into surrounding streams. The change in the channel of the creek and the raising of the water was a natural process for which no legal liability could be placed on defendant. The judgment for plaintiff was reversed.

144
ANDERSON V CITY OF LUDLOW (CITY'S LIABILITY FOR STORM-SEWER OVERFLOW FOLLOWING STREET IMPROVEMNTS),

250 Ky 204, 62 SW2d 785-78 (Ky 1933).

Descriptors: *Kentucky, *Storm drains, *Paving, *Flood damage, Cities, Drainage systems, Sewers, Floodwater, Soil surfaces, Overflow, Surface runoff, Flow rates, Land tenure, Local governments, Legal aspects, Judicial decision, Flow, Road construction, Rainfall-runoff relationships. Identifiers: *Storm sewers.

Plaintiff residential lot owner sought to recover damages from defendant city for flooding resulting from storm sewer overflow. Plaintiff's property was flooded after defendant city paved and constructed catch-basins for nearby streets. The sewer line in question was constructed prior to the incorporation of plaintiff's property into defendant's municipal boundaries. Plaintiff contended that defendant's improvements created the overflow by diverting additional water into the formerly adequate sewer system. Defendant denied that its actions diverted surface water into the sewer lines at issue. The Court of Appeals of Kentucky held that a municipal corporation is not liable for flooding damages where street improvements merely accelerate but do not increase the volume of water flowing into a sewer line in existence prior to incorporation of territory into a city. The court denied plaintiff relief, ruling that defendant's street improvements had only accelerated the flow of water which previously was partially absorbed by trees and soil.

145

CITY OF PERU V CITY OF LA SALLE (RIGHT TO HAVE SURFACE WATERS NATURALLY DISCHARGED),

255 NE2d 502-507 (Ill Ct App 1970)

Descriptors: *Illinois, *Cities, *Drainage water, *Storm drains, Storm runoff, Water rights, Surface runoff, Legal aspects, Drainage systems, Sewers, Outlets, Natural steams.

Plaintiff City of Peru sought an injunction to restrain defendant City of La Salle from draining water through a storm drain from the city limits of La Salle into a ravine which ultimately drained onto property belonging to plaintiff. Plaintiff contended that in the absence of a natural watercourse draining the dominant land onto the serient land, defendant had no right to drain its land through the tile system onto plaintiff's land. Plaintiff also claimed a prescriptive right to be free from the drainage water since defendant's sewer system had drained water away from Peru for the past twenty years. The court denied the injunction stating that even in the absence of a natural watercourse, surface water may be drained into the same point of discharge where it would normally have found its way and the servient landowner cannot complain. The court also held that any prescriptive right that plaintiff asserted would be limited to the amount of water actually diverted by defendant and would not involve other surface water. Plaintiff failed to establish any such amount.

146
CASHIN V CITY OF NEW ROCHELLE (DAMAGES FROM OVERFLOW OF STREAM),

256 NY 190, 176 NE 138-140 (1931)

Descriptors: *New York, *Overflow, *Flood damage, Cities, Streams, Discharge (water), Drainage practices, Sewers, Drainage systems, Legal aspects, Judicial decisions, Riparian rights, Flooding.

Plaintiff landowner sought to recover damages to her property. The damages were allegedly caused by defendant city's collection and subsequent discharge of water into a stream flowing through plaintiff's property. It was argued that such discharge caused the stream to overflow and flood plaintiff's lands. Plaintiff further sought removal of an earth mound left by the city when it constructed a sewer through plaintiff's property. The trial court gave judgment for plaintiff, and defendant appealed on the measure of damages. The New York Court of Appeals, reversing the lower decision, ruled that damages for the overflow of land must be based on the difference between the rental value of such land without the overflow and the rental value with the overflow. The court further ruled that the leaving of the mound was merely a breach of condition of the right-of-way granted to defendant by plaintiff's predecessor. Such condition was for the benefit of the grantor only and gave plaintiff no claim against defendant. A new trial was ordered.

147
LEISL V CITY OF NEWPORT (LIABILITY FOR OVERFLOW RESULTING FROM INADEQUACY OF CULVERT),

258 Ky 506, 80 SW 2d 556-557 (1935)

Descriptors: *Kentucky, *Flooding, *Excessive precipitation, Flood damage, Overflow, Rain water, Judicial decisions, Flow, Conduits, Streams.

In an action for damages, plaintiff contended that defendant municipality negligently constructed and maintained a culvert in a creek. Plaintiff contended that the culvert was inadequate to carry off the waters of the creek in heavy rains, and that such culvert caused waters to back up upon his property, thereby flooding and damaging it. Defendant contended that its duty in maintaining the culvert was to allow for carry off of water during ordinary rains, but not during heavy rains. The court held that one constructing and maintaining a culvert in a creek not adequate to carry off the water during ordinary rains is liable in damages caused by any overflow. However, the court held that there was no liability for such overflow resulting from extraordinary or heavy rains. The court affirmed the trial court's granting of defendant's demurrer since plaintiff's complaint alleged that the overflow resulted from heavy rains.

148

WILKINSON V CITY OF INDIANOLA (OVERFLOW OF CITY SEWAGE SYSTEM),

278 NW 326-327 (Iowa 1938).

Descriptors: *Iowa, *Sewers, *Overflow, *Municipal wastes, Drainage systems, Sewage disposal, Storm drains, Storm runoff, Public health, Judicial decisions, Legal aspects.

Plaintiff property owner sued defendant city for damages resulting from the overflow of municipal sewage onto plaintiff's land. Defendant had opened the surface water intake to a sewer, although the sewer was solely designed for sewage disposal and was inadequate for storm sewer purposes; the sewer had overflowed onto plaintiff's land on several occasions. Plaintiff contended that defendant was negligent in opening the storm intakes. The court held that the evidence was sufficient to be presented to the jury, and affirmed the judment of the lower court for plaintiff.

149

TRUSTEES OF UNIVERSITY CO-OPERATIVE CO V CITY OF MADISON (DUTY OF CITY TO MAINTAIN CITY SEWER SYSTEM),

288 NW 742-747 (Wis 1939).

Descriptors: *Wisconsin, *Storm drains, *Flood damage, *Drainage effects, Damages, Sewers, Rainfall intensity, Seepage, Surface waters, Judicial decisions, Legal aspects, Storm runoff, Drainage systems.

Plaintiff brought action to recover damages for injury to his property allegedly caused by defendant city's defective and clogged storm drain to which plaintiff's roof drainpipe connected. The court found the evidence to be sufficient to support the verdict that defendant was negligent in damaging the storm drain used by plaintiff and in failing to repair the defect after receiving notice thereof. The court stated that if a duly adopted and executed plan of sewage disposal becomes out of repair to the knowledge of the municipality, the duty devolves upon it to remedy the matter, and it is liable for failure to exercise ordinary care in respect thereto. The judgment for plaintiff was affirmed except as to a part of the damages allowed. As to that part of the damages, a new trial was ordered.

150
HERSHEY BEVERAGE CORP V CITY OF SCHENECTADY (MUNICIPAL LIABILITY FOR FLOOD DAMAGE),

291 NYS 256-257 (App Div 1936).

Descriptors: *New York, *Sewers, *Flood water, *Storm runoff, Judicial decisions, Legal aspects, Damages, Storm drains, Storms, Outlets, Maintenance.

Plaintiff corporation brought a negligence action against defendant city for damages which resulted from flooding of its premises. Defendant allegedly had failed to install and maintain sewers adequate to drain rainfall without flooding a particular street and had improperly installed a sewer drain in such street. From a jury verdict for defendant, plaintiff appealed. In affirming per curiam, the court held that the jury could have reasonably found that plaintiff's cellar was damp at all times, that his premises were in a low section of the city, that the sewers were adequate, that the rainfall causing the damage was of extraordinary quantity, and that plaintiff's own outlets to sewers were improperly maintained.

151
ROSITZKY V BURNES (FLOOD DAMAGE TO ADJACENT BUILDING CAUSED BY OVERFLOW FROM ROOF),

295 SW 830-833 (Mo 1927)

Descriptors: *Missouri, *Drains, *Flood damage, Rainfall, Overflow, Storm drains, Legal aspects, Floods, Roofs, Pipes.

In an action to recover water damages, plaintiff alleged that defendant had allowed gravel and other trash to accumulate on defendant's roof. During heavy rainfall, runoff from defendant's roof overflowed onto plaintiff's adjacent building, carrying with it much of this trash and clogging plaintiff's drains. Water was therefore backed up into plaintiff's building, causing flood damage. The court found that plaintiff's drains were negligently clogged. However, defendant contended that it did not occupy the premises in question, but leased it to a third party, and that under Missouri law a lessor was not liable for such damage caused while the tenant was in possession. The appellate court, however, found that there was no allegation or evidence of any lease in the record. Defendant was therefore held liable for the damage caused by the overflow.

152

LATHAM V DES MOINES ELECTRIC LIGHT CO (WATER DAMAGE CAUSED BY BURSTING STORM SEWER),

296 NW 372-376 (Iowa 1941).

Descriptors: *Iowa, *Storm runoff, *Sewers, *Electrical equipment, *Water injury, Drainage systems, Storm drains, Underground structures, Water pressure, Judicial decisions, Legal aspects, Damages, Surface runoff.

Plaintiff building owner sued defendant electric company for damages to his building caused by a broken sewer. Defendant had installed an electrical conduit across a sewer which was laid under the street in front of plaintiff's building. The conduit occupied the top 40% of the sewer's interior diameter. During a heavy rainfall, the sewer burst at the conduit-sewer intersection, causing the water to escape, wash away the foundation of plaintiff's building, and collapse a wall. Plaintiff contended that defendant had negligently installed the conduit so as to obstruct the sewer and that this was the proximate cause of his injury. The court stated that defendant should have used reasonable care in installing the conduit, and that defendant was negligent if it had obstructed the sewer so that injury to others was reasonably apparent. Finding that the evidence established a question for a jury, the court held that the lower court had erred in directing a verdict for defendant.

153

CHELTENHAM AND ABINGTON SEWERAGE CO V PUBLIC SERVICE COMMISSION (OWNERSHIP OF STORM DRAINAGE SYSTEM),

311 Pa 175, 166 A 649-652 (1933)

Descriptors: *Pennsylvania, *Storm drains, *Surface runoff, Urbanization, Drainage system, Sewers, Streams, Judicial decisions, Legal aspects, Storm runoff.

Plaintiff sewerage company appealed an order of defendant Public Service Commission which denied plaintiff's request for permission to charge for storm drainage service. Plaintiff's predecessor had installed conduits in streambeds to form a storm drainage system for a subdivision. A sewerage system was also installed by plaintiff's predecessor, separately and disconnected from the storm drainage system. Defendant contended that plaintiff did not own the storm system. The court determined that a conveyance to plaintiff by the subdivision promoter included only the sewerage system, and that if the storm system had been included, charges could not be exacted for its use, since the storm system was merely a substitute for natural drains. Property owners have a right to use artificial conduits for drainage of surface waters formerly carried away by natural streams. Furthermore, the court noted that there was meager evidence of maintenance of the storm system or other indications of ownership. The court held that plaintiff did not own the storm drainage system and consequently could not charge for its use.

154

WATER POLLUTION AND IMPROVEMENT OF SEWER SYSTEM,

Takae Fujisawa
Toki no Horei, No 744, pp 10-26, Mar 23, 1971.

Descriptors: *Sewerage, *Public health, *Water pollution, Standards, *Legislation, Future planning, Sewers, Water quality.
Identifiers: *Japan.

Only 22.8% of the urban areas in Japan are equipped with sewer systems. As a result, the urban environment is deteriorating rapidly, and pollution of rivers, lakes, and seas has become a serious problem. To rectify the delay in the development of sewer systems, the first five-year sewer-system plan was started in 1963, followed by the second five-year plan in 1967. While the problem in advanced countries in Europe and America is how to dispose of sewage, the problem in Japan is twofold: to extend the sewer system and to dispose the collected sewage efficiently. At the 64th Extraordinary Diet session, a partial amendment to the Sewer System Law was passed. This law has as its objectives the safeguarding of public health and the maintenance of the quality of public waters. The definition of a public sewer system was amended to mean that the system either has a terminal disposal plant or is connected to the sewer system of a river basin. So that designated rivers and other public waters and seas meet water quality standards, an overall basic plan for improving the sewer system must be developed with approval by the Minister of Construction. Items covered by the plan include the basic policy of sewer system improvement, placement of basic facilities, structures, and orders for execution of construction programs. Water quality standards for 40 water bodies were determined at a Cabinet meeting on September 1, 1970; more waters are to be added in the future. The amendment to Article 9 of the Pollutions Countermeasure Basic Law entrusts the designation of types of waters to governors and that water quality standards are applicable to major waters throughout Japan. In the case of regional sewer systems, which lie outside the administrative boundaries of cities, towns, and villages, the national government subsidizes one-third of survey expenses. Under the law, those who discharge wastewater to public sewer systems must change to flash toilets and also measure water quality and record the results. Fees can be charged users of public sewer systems according to the manner of utilization, and qualifications of those responsible for maintenance and control of terminal sewage disposal plants are stipulated. Local communities which benefit from the sewer system of a river basin are to bear expenses in accordance with the degree of benefit they derive from the system, as established by prefectural governments. Under the new law, the Minister of Construction is entitled to supervise the maintenance and control of terminal disposal plant, those responsible for the sewer system must adequately dispose of such sludge. The third five-year sewer-system improvement plan is to start in 1971.

155

LIABILITY OF A WATER AND SOIL PROTECTION AGENCY FOR FLOOD DAMAGE,

E. Hussla
Wasserwirt, Vol 61, No 2, pp 54-55, Feb 1971.

Descriptors: *Flooding, *Flood damage, Flood protection, Judicial decisions, Overflow, Legal aspects.
Identifiers: *Germany.

In the years 1957 and 1958 a river flooded the premises of a business woman who was not a member of the Water and Soil Protection Association. The flood caused damage to the business she was operating on these premises. When she filed suit against the Association and demanded that they make good for the flood damage she suffered, the municipal and state courts upheld her charges. The federal court declined a revision of the case and upheld the verdicts of the lower courts. It was stated that the accused Association had the task of protecting the area against floods by construction of dams and that this task also extends to the premises of non-members.

156

SEWER AND ENVIRONMENTAL ASPECTS OF WATER QUALITY STANDARDS,

Munehito Kuribayashi
Kogai to Taisaku, Vol 6, No 8, pp 631-634, Aug 15, 1970.

Descriptors: *Sewers, *Design, *Treatment facilities, *Waste treatment, Water quality, Standards, Drainage, Sewerage.
Identifiers: Japan.

Improvements of existing drainage systems and extensive development of drainage works are required on the present sewer systems in order to comply with new water quality standards. Large-scale sewerage works, planned on a basin area unit system, have more advantages because of the mixture of treated wastes produced. Advanced system engineering dealing with dynamic programming and multi-level-techniques will be employed in this sewer scheme which eventually may decide general water quality.

157

THE DESIGNATION OF THE AREA AND THE WATER QUALITY STANDARD OF THE RIVER KANO,

Yoji Ogawa
Kogai to Taisaku, Vol 6, No 7, pp 541-549, Jul 15, 1970.

Descriptors: *Water pollution sources, *Water quality control, *Standards, *Water pollution control, Urbanization.
Identifiers: *Japan, *Kano River Basin.

The Kano River Basin supports fresh water fish and the water is used for irrigation purposes. Industrial development and urban growth in the vicinity of the river basin have contributed to the water pollution problem. The Economic Planning Agency which investigated the quality of the basin water in the years 1966 and 1967 designated the water area and the water quality standard so as to maintain water quality control. By the year 1975, the pollution degree is estimated to decrease approximately 60% with water pollution control based on the new standard.

158

INDUSTRIAL ENTERPRISE AND SEWER SYSTEM OPERATOR MADE RESPONSIBLE FOR FISH KILL,

Sander
Wasser Luft Betrieb, Vol 15, No 4, p 155, 1971.

Descriptors: *Fishkill, *Judicial decisions, Phenols.
Identifiers: Disinfectants, Desintan, Germany.

On December 18, 1956 carp, trout, and tench in river water were killed by a liquid containing phenol. The fishing rights to the river belonged to a large fish store. The owner of the store filed suite. An investigation revealed that the phenol had come from rinsing barrels that once contained a disinfectant called Desintan, which is no longer on the market. The rinsing water drained off into the sewer system and from there it entered the river. The owner of the barrels, who operated a drugstore, and the city responsible for the sewer system were sentenced to make amends for the damage.

159

METHODOLOGY IN ESTABLISHING WATER-QUALITY STANDARDS,

Robert O. Sylvester and Carl A. Rambow
Water Resources Management and Public Policy, University of Washington Press, pp 110-122, 1968. 2 tab, 3 ref.

Descriptors: *Water quality, *Standards, *Washington, *Methodology, *Water quality control.

The methodology for establishing water quality criteria as presented here was done for the state of Washington where most waters do not suffer from damaging pollution. Some aspects of the methodology may be more difficult to apply to regions where most waters are more severely damaged by pollution. A comparison of the goal and standard values, with present water quality and minimum recorded water quality in forty principal stream reaches in the state of Washington gave the following results for nine parameters: in the case of present quality about 92% exceeded goal values, 6% lay between goal and standard values and about 2% fell below standard values; in the case of minimum recorded water quality, about 73% fell above goal values, 11 between goal and standard values, and 16% below standard values.

SECTION 8.

Treatment Methods and Reuse

160

TESTS MICROSTRAINING AND OZONE ON STORMWATER OVERFLOW,

Am City, Vol 86, No 1, pp 28, Jan 1971.

Descriptors: *Waste water treatment, Ozone, Pilot plants.
Identifiers: *Storm water overflow, *Microstraining, *Philadelphia, Pennsylvania, Ozonation, Combined sewers.

A pilot-plant study, experimentally undertaken to combat storm water overflows from combined sewers located in the Philadelphia area, embraced microstraining to remove the polluting solids and ozonation to disinfect the effluent. The pilot plant draws a portion of the overflowing wastewater containing raw sewage and settled solids to a Crane Microstrainer, a revolving drum with the perimeter covered by a specially woven stainless steel wire cloth. The storm water enters through one end of the drum and flows outward through the metal fabric leaving behind the polluting suspended solids which are carried upward to the top of the drum where wastewater jets flush them down into a receiving hopper on the axle of the drum. The storm water then flows to a holding tank where it is treated with ozone for sterilization and elimination of possible viruses and bacteria. To generate the ozone, air passes through refrigeration coils, through silica-gel desiccators, and then flows through a narrow discharge gap between electrodes operating at 15,000 volts, thus becoming ozonated.

161

COMBINED SEWER OVERFLOW COLLECTION AND TREATMENT FACILITY,

Consulting Engr, Vol 36, No 5, p 102, May 1971. 2 fig.

Descriptors: *Overflow, *Sewers, *Sewage treatment, *Treatment facilities, *Water reuse, Storm runoff.
Identifiers: *Mount Clemens, Michigan, Combined sewers.

The combined sewer overflow collection and treatment facility of the City of Mount Clemens, Michigan is based on the following concept: (1) intercept and convey the combined sanitary and storm overflows to the treatment site; (2) treat the overflow by a series of aerated lakelets with intermediate microstraining, chemical treatment, disinfection, and high rate pressure sand filtration prior to discharge into a stream; and (3) develop the treatment site as a park for recreation and as a buffer zone between residential and commercial-industrial areas. The 24-acre site serves a 250-acre watershed area. The total cost, exclusive of park construction, was $825,000.

162
PUMP INSTALLATION FOR SEWAGE,

Netherlands Patent NL 6817242.

Descriptors: *Patents, *Sewerage, *Pumping plants, Overflow, Pipelines.

This installation is especially good for pumping sewage containing larger sized pieces without separation or processing. The collector feed pipe is connected in normal circumstances to the collecting reservoir by a feed pipe and a pump with its associated suction and delivery pipes. In exceptional conditions the system is connected via an overflow situated as close as possible above the feed pipe to the sewage pit and consists of an overflow pipe, horizontally below which is fixed a grid, and separated from the incoming liquid flow by a vertical baffle wall which lies along the diameter of the pit and above the feed pipe.

163
PHYSICAL-CHEMICAL TREATMENT OF SEWAGE,

Effluent Water Treat J, Vol 10, No 11, pp 673, Nov 1970.

Descriptors: *Sewage treatment, *Pilot plants, *Laboratory tests, *Activated carbon, Coagulation, Sludge, Costs.
Identifiers: *Storm sewage, *Combined sewers, *Chemical treatment, Battelle Northwest Institute.

A physical-chemical system for treatment of combined storm sewage is being developed on a pilot plant scale by the Battelle Northwest Institute in Washington. Laboratory studies have attempted to optimize a process for solids and organic removal with minimum detention time and chemical doses. The evolving process uses powdered activated carbon at 600 to 1000 mg/l, coagulation with alum (200 mg/l) and polyelectrolyte (2.5 mg/l), followed by high-rate tube settling, and with an overall detention time of 30 minutes. The sludge, containing carbon and aluminum hydroxide was thermally regenerated by two alternative processes, each giving about 90% carbon recovery. Sulphuric acid extraction of the regenerated mixture recovered about 85% of the alum. Preliminary costs indicate 18.9 cents/1000 U.S. gallons and a capital cost of $1.2 million for 10 mgd (U.S.) plant. The 0.1 mgd capacity pilot plant is mobile and is equipped with instruments for continuously recording flowrates, pH, turbidity, and organic carbon.

164

REGIONAL SEWER SYSTEM IS NO DREAM IN DETROIT,

Eng News- Record, Vol 185, No 24, pp 24-25, Dec 1970.

Descriptors: *Water pollution control, *Treatment facilities, *Planning, Sewage treatment, Storm runoff, Overflow, Construction, Costs.
Identifiers: *Detroit, Michigan.

The Detroit Metropolitan Water Department's plant to incorporate six counties into a massive regional sewage collection and treatment system that will reduce water pollution in the Great Lakes and connecting waters and seven rivers was discussed. The first of the three phases of the 4,000 square mile area construction plan consists of the erection of a 28 mile long intercepter. By 1975, DMWD plans to have an additional $290 million in treatment plants and interceptors under construction. Advantages include a 600-mgd oxygen operated aeration tank for the activated sludge process, 2 additional primary sedimentation tanks adding 300-mgd to the sewage treatment capacity, a 1.2-mgd chlorine contact conduit, and phosphate removal facilities. Phase 2 brings in 4 counties and phase 3 will expand the system to the entire metropolitan area with an estimated population of 8.5 million. Because storm water flow is a major contributor to the pollution of southern Michigan streams, DMWD is installing a monitoring system to detect approaching storms which comprises rain gages, sewer level sensors and overflow detectors connected to a central computer, datalogger and operating console that activates pumping stations, and selected regulating gates.

165

A PHYSICAL - CHEMICAL SYSTEM FOR TREATMENT OF COMBINED STORM SEWAGE,

Committee on Sewerage and Sewage Treatment, Ralph Stone (Chairman)
J Sanit Eng Div, Am Soc Civil Engrs, Vol 96, No SA4, Proc Paper 7477, pp 993-994, Aug 1970. Included in the article: "Sewerage and Sewage Treatment: State-of-the-Art Abstracts".

Descriptors: *Water pollution control, *Sewage treatment, *Activated carbon, *Pilot plants, Laboratory tests.
Identifiers: *Storm sewage.

This is a report on ongoing research, conducted by A. J. Shuckrow, G. W. Dawson, and A. T. Brix, covering enumeration and evaluation of the factors which should affect decisions as to the degree of water pollution control required in each specific situation. Powdered activated carbon may be utilized in a physical-chemical process for the treatment of combined storm sewage. The program involves laboratory development of the process, design and construction of a 100,000 gpd mobile pilot plant, and demonstration of the process. The process involves contacting the wastewater with powdered activated carbon and subsequent coagulation with alum and a polyelectrolyte followed by high-rate tube settling. The process appears to meed the following desirable characteristics for treatment of combined storm sewage: short detention time, intermittent use with capability to tolerate widely fluctuating flows and wastewater composition, small space requirements, high quality effluent, and economical operation. Based on the laboratory findings, the mobile pilot plant is being designed to fit into a standard forty-foot trailer van with the exception of the carbon regeneration facility, which will be skid mounted. The system is designed for maximum operational flexibility and includes turbidity, pH, and flow measuring instruments in addition to the continuous organic carbon analyzer.

166
FIRESTONE INSTALLS POLLUTION CONTROL,

Oil Gas J, Vol 68, No 35, P 79, Aug 31, 1970.

Descriptors: *Water pollution control, *Treatment facilities, Control systems, Concrete construction, Separation techniques.
Identifiers: *Industrial treatment, *Storm water treatment.

A water pollution control system, which separates storm and industrial effluent and treats plant wastewater before release into the bayou, is being installed. This $8.8 million operation provides the Firestone plant with a separate industrial effluent collecting system and a separate storm water collecting system, thus the possibility of flushing the two systems together during a heavy rainfall is eliminated.

167
NEW SEWAGE TREATMENT WORKS FOR BLYTH AND MORPETH,

Surveyor, Vol 136, No 4097/4098, pp 44-46, Dec 1970.

Descriptors: *Sewage treatment, *Treatment facilities, *Equipment, Sewage disposal, Separation techniques, Flow separation, Sludge

treatment, Storm runoff, Storage tanks, Drainage systems, Tertiary treatment.
Identifiers: *Great Britain.

An overall sewage disposal scheme, whose first stage provides primarily for a newly constructed foul and surface water drainage system, has been developed for the whole of Blyth. The existing inlet works, comprising mechanically raked screens, flow recorder, detritus channels, and storm water overflows, have been retained in stage one. Flows between 3 DWF and 6 DWF are separated and passed to the original three sedimentation tanks, which are now serving as storm water tanks and have a combined capacity of 168,750 gallons. Primary settlement takes place in two rectangular, horizontal flow tanks with a capacity of 333,000 gal.; settled sewage passes to four aeration tanks, each of which is fitted with a high intensity aeration cone driven by a 10 hp motor; and sludge treatment units comprise an elevated circular sludge storage tank, two circular conditioning tanks, lime and copperas mixing tanks, and the filter press house. The Morpeth works have been designed to treat a DWF of 915,000 gpd with tertiary treatment to meet standards of 20 mg/l suspended solids and 15 mg/l BOD. Flows in excess of 6 DWF are passed over a storm overflow weir to the river without further treatment, and flows from 3 DWF to 6 DWF receive partial treatment in storm water tanks before being discharged. Settled effluent passes via a flow dividing chamber and two dosing chambers to seven percolating filters; filtered effluent passes through a flow dividing chamber to two circular, mechanically scraped humus tanks, where finer solids settle out; two microstrainer units provide tertiary treatment for humus tank effluent; and sludge is pumped continuously from the storage wells to a small conditioning tank where lime and copperas are added before it gravitates to a sludge bath in which the bottom of the filter drum is immersed.

168
SOUTHWEST U.S. FACES RESOURCES PROBLEMS,

Water Wastes Eng, Vol 8, No 2, pp 31, Feb 1971.

Descriptors: *Water supply, *Feasibility studies, *Water resources development.
Identifiers: *Southwest U.S.

Because of the lack of an adequate surface source, the entire supply of water to the urban and metropolitan areas in Southwest U.S. come from groundwater storage. In order to prevent the rapid decline of the water table and possible exhaustion of groundwater supplies, supplemental supplies of water must now be investigated and developed for the Tucson Metropolitan area. The use of secondary sewage effluent in irrigation, the reclamation of domestic wastewater, the value of storm runoff for reuse, and the analysis of storm water from various urban watersheds are being studied for application in regions such as Tucson where resource problems are critical.

169

CHEMICAL TREATMENT OF COMBINED SEWER OVERFLOWS,
The Dow Chemical Company

EPA/WQO Contract No 14-12-9, Program No 11023 FDB, Sep 1970. 185 p, 56 fig, 50 tab.

Descriptors: *Cost analysis, *Disinfection, *Flocculation, *Overflow, *Sedimentation, *Sewage, *Storm runoff, *Settling basins, *Hydraulic design, *Water analysis, Coliforms, Design storm, Rainfall-runoff relationships.
Identifiers: *Combined sewage, *Milk River, *Detroit, Michigan, *Combined sewers.

A typical pumping station and settling basin, characteristics of combined sewage overflows, and chemical treatment with chemical flocculants and disinfectants are described. Average number of days of pumping per year (41) is about equal to average number of days with precipitation ≥0.2 inches (45). Twenty-two analyses of consecutive time-weighted samples of influent and effluent are reported for 33 storms over a two-year period. Biochemical oxygen demand and suspended solids decreased after initial flushing of the sewers; chlorine demand was relatively constant. The discharge channel and immediate receiving bay were severely polluted. Cationic polymeric flocculants and flocculant aids significantly improved removal of suspended solids from combined sewage in the laboratory. Adequate disinfection of the combined sewage before discharge is possible. Performance of the existing basin can be improved by the use of staged continuous pumping at lower rates and the addition of baffles for improved flow distribution.

170

DEMONSTRATE FEASIBILITY OF THE USE OF ULTRASONIC FILTRATION IN TREATING THE OVERFLOWS FROM COMBINED AND/OR STORM SEWERS,
Acoustica Associates, Incorporated

U.S. Dept Interior, FWPCA Contract No 14-12-23, Program No 11020---, Sep 1967. 6 fig, 4 tab, 3 graph, 3 append.

Descriptors: *Ultrasonics, *Filters, *Filtration, Waste water treatment, Treatment facilities, Overflow, Feasibility, Solid wastes, Coliforms,

Suspended load.
Identifiers: *Ultrasonic filtration, *Treatment methods, Toxic materials.

Ultrasonic filtration, using permanent-type low-head filter elements mounted within canisters into which ultrasonic energy is applied on a programed basis, has been found technically and economically feasible for full-scale wastewater treatment. With this system, the total quantity of influent filtered between backwash cycles is from four to 18 times that of similar filter elements without ultrasonic energy; the length of filter runs between backwashing is four to ten times that of ordinary elements; and, ultrasonic energy used during backwashing can restore the elements to "like-new" condition.

171
THE BENEFICIAL USE OF STORM WATER: Final Report,
Hittman Associates, Incorporated

U.S. Dept Interior, FWPCA Contract No 14-12-20, Program No 11030DNK, Aug 1968. 42 fig, 83 tab, 47 graph, 46 ref, 8 append.

Descriptors: *Water reuse, *Storm runoff, *Water treatment, *Water storage, *Water pollution, Evaluation, Costs, Feasibility, Water pollution control.
Identifiers: *Columbia, Maryland, *Wilde Lake, Maryland.

The local storage, treatment, and reuse of storm water is a concept for the control of storm water pollution in which storm water runoff is collected in small storage basins dispersed throughout an urban area, treated to remove pollutants, and further treated for use. With this concept, the benefits derived from the use of storm water are used to offset the cost of effecting pollution control. This report contains a description of the system study, design, and evaluation of the local storage, treatment, and reuse of storm water and the analysis of the economic and technical feasibility of this concept. It was concluded that this concept is a practical and economically attractive method of providing pollution control in urban areas.

172
THE URBAN WATER SYSTEM,

M. L. Albertson, D. C. Taylor, and L. S. Tucker
In: Urban Demands on Natural Resources, Western Resources Conference Proceedings, pp 57-65, 1970.

Descriptors: *Municipal water, *Sewers, *Storm runoff, *Water supply, *Water reuse, *Colorado, Surface runoff, Drainage systems.
Identifiers: *Regional planning, Denver, Colorado.

In an urban water system water is located, treated, distributed, used, treated again, and discharged to a receiving body of water. Also, the surface runoff due to rainfall is collected and transported through drainage works to a receiving water body. There are several actions that can be taken to make better use of the water. For example, following treatment, sewage effluent can be additionally treated and put into a reuse system. Storm runoff could be either diverted back to the water supply system, or to a storage area where it could be used for recreational purposes, or both. In addition, regional water planning and management can serve to insure that the maximum effectiveness of its resources is being made. Denver, Colorado is evolving such a total systems concept of water management.

173
OZONATION, NEXT STEP TO WATER PURIFICATION,

Rene J. Bender
Power, Vol 114, No 8, pp 58-60, Aug 1970. 4 fig.

Descriptors: *Ozone, *Water purification, *Waste water treatment, Oxidation, Chlorination, Storm runoff.
Identifiers: *Overflow purification, Philadelphia.

Ozonation is an outstanding method for purifying water, because ozone is a superior oxidizing agent and oxidation helps clean water thoroughly. Workings of the two types of ozonators are diagrammed and described. Ozonation is not yet used in the U.S. to purify municipal drinking water because most state laws demand that chlorination be used. Ozonation does not replace chlorination, but it incorporates chlorine into its process in two forms. Ozonation kills bacteria and viruses faster than does chlorination; in addition, ozone does not affect water taste, and it eliminates the slight chlorine taste introduced during primary treatment. Ozonation costs about twice as much as chlorination, but both are very inexpensive. A U.S. trend is now towards ozonation of wastewater, and one pilot plant in Philadelphia is designed to purify combined sewer and stormwater discharge when flash floods cause untreated water and sanitary sewage to overflow into rivers. Additional uses of ozone in connection with wastewater are mentioned.

174
INDUSTRIAL RE-USE OF COMBINED SEWAGE-TREATMENT PLANT EFFLUENT,

E. R. Hamilton and C. F. Gurnham
International Conference on Water for Peace, Vol 4, 1967 and 1968.
12 p.

Descriptors: *Storm runoff, *Bypasses, *Water pollution sources, *Treatment facilities, Overflow, Sewage disposal, Water reuse.
Identifiers: *Storm sewage, *Chicago, Illinois, *Treatment method.

After reviewing the increasing water demands of the United States and the problems of future water shortage, the authors describe the steps taken at East Chicago, Illinois, to overcome problems of pollution and water shortage. Excess storm sewage which bypasses the sewage works enters Grand Calumet river and thence the southern part of Lake Michigan, causing serious restriction on the use of water for recreational purposes, particularly swimming. It is financially impossible to replace the combined sewerage system by a separate system; also, storm runoff is highly polluting. A scheme was therefore developed which will receive effluent from the existing sewage works and overflows of storm sewage from about one-third of the city, providing treatment by equalization, sedimentation, oxidation, and biological processes. In dry weather there will be a detention period of at least 10 days; and at peak storm periods there will be a minimal detention period of 24 hours. Discharge from the detention basins will be chlorinated and held in the overflow channel for the customary disinfection period of 15 minutes before entering the Grand Calumet river. It is proposed that flows up to 20 mgd will pass from the detention basin to a new tertiary treatment plant, on which pilot-scale studies are being made. The quality of the effluent will not only meet the anticipated standards for discharge to the Grand Calumet river, but will approach requirements for potable use and will be acceptable for use as cooling water and often as industrial process water. The plant will be flexible in operation, and water of almost any desired quality could be tapped off at various points for sale to industry.

175

INSTRUMENTATION AND CONTROL RELATIVE TO THE PROBLEMS OF WATER POLLUTION,

S. H. Jenkins
Measurement Control, Vol 4, No 2, pp T21-T22, Feb 1971.

Descriptors: *Monitoring, *Automatic control, *Sewage treatment, *Effluents, Quality control, Instrumentation, Water pollution control.
Identifiers: *Sensors.

The development of a sensor which makes it possible to measure a particular water quality automatically is desired for water quality monitoring. There exist such sensors for qualities including dissolved oxygen, ammonia, nitrate, pH, phosphate, fluoride, COD metals, synthetic detergents, and suspended solids. Other qualities, such as fish toxicity, are still in need of sensors for testing. Automatic sensors make possible better effluent control and increased use of automatic sewage processing.

176

THE SEWER SYSTEM OF THE CITY OF WIESBADEN,

Wolfgang Jesse
Gas- Wasserfach (Wasser/Abwasser), Vol 112, No 2, pp 68-71, 1971. 3 fig, 1 ref.

Descriptors: *Treatment facilities, *Sewerage, *Activated sludge, *Domestic wastes, Sewers.
Identifiers: *Thermal sludge rotting, Germany.

The wastewater of the city of Wiesbaden is almost exclusively of a domestic nature. There is no sizeable industry. Only the runoff from the hot springs goes into the sewer system. The relatively high salt content does not cause any interference with the purification process. In 1950, a mechanical purification plant with thermal sludge rotting was built. The sewer gas developed in the sludge rotting process has been used for heating the public indoor swimming pool. Meanwhile, the plant has become too small and in the planning stage are a sludge rotting station, sludge dehydration station, and a biological purification station. The activated sludge method has been selected for biological purification.

177

EXTENSIONS TO THE WATER POLLUTION CONTROL WORKS AT CIPPENHAM, SLOUGH,

B. R. Kinnear
J Inst Municipal Engrs (London), Vol 98, No 4, pp 95-104, Apr 1971. 15 fig, 1 tab.

Descriptors: *Treatment facilities, Activated sludge, Sludge treatment, Instrumentation, Automatic control, Construction, Sedimentation, Aeration, Humus, Filtration.
Identifiers: Great Britain.

The Slough Corporation's water pollution control works at Cippenham have been extended to include: a flow divider where water is equally divided over 6 identical weirs; two circular, mechanically scraped sedimentation tanks, each with 3300 m^3 capacity; two aeration units, each with 4546 m^3 capacity and provision for distribution of anti-foam oil; four circular, mechanically scraped activated sludge separation tanks, each with 1710 m^3 capacity; four horizontal spindle variable speed axial flow return pumps to pump sludge to the aeration units at 0.039 m^3/s to 0.158 m^3/s; two biological filter beds of volume 10360 m^3 with blast furnace slag media; four circular, mechanically scraped humus tanks, each with 1590 m^3 capacity; and, storm water/balancing tanks, of total capacity 6380 m^3 not mechanically scraped, and two mechanically scraped each with capacity of 3190 m^3. A central control panel connected with meters and control valve actuators by telephone type multicore signal cables controls a comprehensive system of instrumentation and automatic control. The extensions to the sludge treatment plant consist of two heated primary sludge digestion tanks of capacity 2270 m^3 with floating gasholders, floor-raking mechanisms, and axial flow sludge re-circulating pumps.

178
TERTIARY TREATMENT OF SEWERAGE WATER,

Shozo Miyahara and Tokiya Ando
Sangyo Kogai, Vol 6, No 8, pp 454-461, Aug 25, 1970. 46 ref.

Descriptors: *Tertiary treatment, *Water purification, *Water resources, *Feasibility.
Identifiers: *Sewerage water, *Japan.

Because of the increasing water need, the feasibility of sewerage water reuse is being investigated both technically and chemically. This new advanced method of utilization, tertiary treatment, is aimed at higher level purification of sewerage water beyond the secondary treatment stage. Due to projected water demand sewerage water has a great potential as a new water resource if advanced technology is employed. Some problems involved in sewerage water reuse are associated with water quality including: generation of corrosion, slime scale and ABC foaming, higher seasonal temperatures, and chloride ion concentration. Sewerage water reuse is presently limited in its application to cooling and washing uses. Discussed herein are several types of tertiary treatment for sewerage water primarily involving removal of suspended solids, nitric or phosphoric compounds, organic substances, and chlorine contained in sewerage water after secondary treatment.

179
RAINWATER DILUTION OF PROCESS WASTES,

Charles W. Moores
Petro/Chem Eng, Vol 43, No 4, pp 39-40, Apr 1971. 2 fig.

Descriptors: *Storm runoff, *Chemical wastes, *Detention reservoirs, Effluents, Overflow, Rainfall-runoff relationships.
Identifiers: *Chemical plants.

Storm water runoff from chemical process plants is often initially highly contaminated. Yet this contamination decreases as the rain continues until the runoff is essentially unpolluted. Unless this relatively pure water is separated from the highly contaminated water and other plant effluents, pollution control becomes more difficult and more expensive. A water impounding tank system with an overflow arrangement is seen as a solution to this problem. Rain falling on paved operating areas washes contaminants into a sewer, through which it travels to an impounding tank. When the water in the tank reaches a certain level, a pump starts to transfer it to the treatment system. When the water reaches another, higher level, incoming rainwater is diverted to a surface drainage ditch. The higher level is positioned allowing water to reach the tank after rainwater from the most remote contaminated area has reached the tank. Some measurable contamination of water which overflows or bypasses the impounding tank may occur.

180
PLANNING OF MUNICIPAL WASTEWATER RENOVATION PROJECTS,

J. W. Porter
J Am Water Works Assoc, Vol 62, No 9, pp 543-548, Sep 1970.
3 fig, 2 tab, 6 ref.

Descriptors: *Water reuse, *Economics, *Cost comparisons, *Project planning, Water pollution control.

Increasing interest in water renovation and reuse rather than simply waste treatment and discharge is due to the severity of pollution control laws and localized shortages of water resources. Economic considerations concern cost comparisons between the water pollution control/water supply functions of a water renovation facility, and the same functions in separate facilities. Technical considerations in planning a water renovation project are largely a function of the planned use of the product water. Several technical aspects are discussed including: process selection and water quality criteria, renovation system reliability, public health considerations, and pilot - demonstration work. The functions of water pollution control and water supply should be recognized institutionally, which involves cooperation between parties concerned. Five guidelines are included as suggestions in planning for public acceptance of water renovation.

181
NEW APPROACH TO APPLIED RESEARCH,

Irvin M. Rice
Water Wastes Eng, Vol 8, No 2, pp 20-22, Feb 1971.

Descriptors: *Pilot plants, *Treatment facilities, *Storm runoff, *Urbanization, *Contracts, *Research and development, *Infiltration, Water reuse, Feasibility studies.
Identifiers: *Sewer flow, *Dallas, Texas.

The existing contract between the City of Dallas and Texas A & M University may prove to be of far-reaching importance in the search for solutions to the twin problems of providing an adequate water supply and alleviating the pollution problem in streams. Under the terms of the contract, the foundation agreed to direct and administer the Dallas wastewater and water reclamation programs at the research center. Direction, with an objective of finding an answer to the problem of handling excess flows in sewers caused by storm water infiltration, is given to the pilot operation of a storm water treatment facility. The long term objective of the combined effort is to fully exploit the potential of the water reclamation center in developing improved treatment processes to meet more stringent pollution control demands of the coming decade. Results from the pilot plant study indicate that allowable infiltration tolerances have been progressively reduced and for new sewer construction the upper limit is 300 gpd per inch of pipe diameter per mile. A study is in progress to determine the extent of infiltration into the older house laterals and collectors and to develop a feasible program of tightening up the older parts of the system.

182

TREATMENT OF RAW AND COMBINED SEWAGE,

A. J. Shuckrow, G. W. Dawson, and D. E. Olesen
Water Sewage Works, Vol 118, No 4, pp 104-111, Apr 1971. 1 fig, 7 tab, 6 graph, 13 ref.

Descriptors: *Activated carbon, *Flocculation, *Laboratory tests, *Sewage treatment, Flow rates, Overflow.
Identifiers: *Combined sewage, *Raw sewage, *Inorganic coagulant, *Polyelectrolyte, *Organic removal, *Regeneration, *Recovery, *Physical-chemical process, Alum, Detention time, Process economics, Richland, Washington, Seasonal variations.

A physical-chemical process for the treatment of raw or combined sewage has been developed on a laboratory scale. The process involves contacting combined sewage with powdered activated carbon to effect removal of dissolved organic matter. An inorganic coagulant is then used to aid in subsequent clarification. Addition of an organic polymer follows and then a short period of flocculation. Solids are separated from the liquid stream by settling, and the effluent is then disinfected and discharged. Carbon sludge from the process can be thermally regenerated and the inorganic coagulant can be recovered and reused. Process economics, on the basis of laboratory findings, indicate capital and operating costs for a 10 mgd facility of $1.2 million and 18.9¢/1000 gal respectively.

183

CLEANER STREAMS FROM BUSIER SEWERS,

Darrel Suhre
Water Sewage Works, Vol 117, pp R109-R112, Nov 28, 1970.

Descriptors: *Sewers, *Storm runoff, *Monitoring, *Control systems, *Water pollution control, Drainage systems, Remote control, Water pollution sources.
Identifiers: *Regional planning, Combined sewers.

To show how community sewer and drainage systems can be improved, this article proposes regional control centers, monitoring systems, and remote control. Results of such programs will be more efficient control of sewer and storm drainage and combined sewer overflows to prevent pollution of receiving waters. Cleaner streams at less cost should be achieved.

184

URBAN WASTE STABILIZATION POND,

Norman Van Sickle
Water Sewage Works, Vol 117, No 12, Dec 1970. 1 fig.

Descriptors: *Sewage lagoons, *Treatment facilities, *Separation techniques, *Project feasibility, Overflow, Systems analysis, Urban renewal.
Identifiers: *Combined sewers, Storm water overflow.

Sewage lagoons require very little treatment mechanisms and maintenance expenditures are nominal. When satisfactorily operating, a pond is facultative; it has an aerobic zone in the bottom portion, but becomes aerobic in the upper levels. Solids settle to the bottom and undergo anaerobic decomposition, but the odorous products of these are oxidized on the way to the surface. In the past lagoon or pond treatment has been considered applicable only to rural areas. In the consideration for the application of works to urban waste treatment the following factors would enter: 1) area for treatment purposes with the required oxygen content, 2) temperature control for optimum algae growth, and 3) algae removal before it becomes a pollutant. It may be practically and economically feasible to use ponds that are very deep, that use submerged artificial light, and that maintain a favorable temperature, especially bearing in mind the practicability of maintaining three or four layer stratification within the cell. To combat back-ups in combined sewers during storm flow conditions, new separate sanitary sewage collection systems would be less costly than under present system practice provided the deep treatment cells proved practicably sound for urban use.

185
WASTE WATER AND STORM FLOW TREATMENT (LITERATURE REVIEW),

D. J. Weiner
J Water Pollution Control Fed, Vol 42, No 6, pp 963-969, Jun 1970.
42 ref.

Descriptors: *Storm runoff, *Waste disposal, *Sewerage, *Sewers, *Overflow, Waste water treatment, Pipes, Construction, Operation and maintenance.
Identifiers: *Treatment methods, Storm sewers, Combined sewer overflow.

The role of wastewater transportation, control, and treatment was being reemphasized as part of the requirements in improved control and improvement of the environment. New communities have demanded sewerage services and older municipalities expanded sewage facilities into new areas as they found that residents expected to receive adequate sewage facilities into new areas as they found that residents expected to receive adequate sewage services. Sewers continue in importance as an economical and efficient means of waste disposal. Several reports presented various aspects and problems connected with different types of pipes for sewage use. These included clay pipes, concrete pipes, asbestos concrete pipes and PVC pipes. Maintenance programs and safety programs were described in several papers. Also presented were construction programs incorporating pipe testing and root control methods for new and renovated sewers. The control and treatment of overflows from combined sewers have attracted attention and interest of several papers as the total water pollution control program grows. Regulation and treatment of overflows have been investigated in the United States and other countries. A variety of programs in several cities for treatment of the combined sewer overflows were discussed.

SECTION 9.

Hydrology

186
FLOW DISTRIBUTION IN STREET INTERSECTIONS AS DETERMINED BY EXPERIMENTAL HYDRAULIC MODEL STUDIES,
Los Angeles Bureau of Engineering, California, Storm Drainage Division

1952-1953. 63 p, 59 fig.

Descriptors: *Storm runoff, *Flow rates, *Flow measurement, *Water measurement, *Drainage systems, *Hydraulics, *Drainage engineering, *Model studies, Urbanization.
Identifiers: *Street intersections, *Street drainage, *Los Angeles, California.

The publication is an assembly of 59 different sets of charts which can be used in designing urban streets and drainage systems. The charts were developed for determining storm runoff flow distribution in right-angle street intersections. Each chart reflects predetermined prototype inflow quantities of water which may reach a right angle cross-street intersection from two directions under varying conditions of street widths, slopes, crowns, and crossfalls. Based upon a given set of conditions, the distribution of the combined inflow can be determined at the street intersection as it emerges from the intersection, in the two outflow street sections. These calculated quantities can then be used in the design of street storm water inlets, catch basins, and storm sewers. The charts were developed from experimental hydraulic model studies conducted by the City of Los Angeles over a 16 month period. The models were built to a 1:15 scale. Much of the data was developed from an adjustable model, in which the significant physical parameters could be varied to simulate prototype conditions worthy of study. Initially, the work was jointly sponsored by the California State Division of Highways and the City of Los Angeles. The City later continued and expanded the studies to result in the subject publication.

187
URBAN HYDROLOGY,

W. J. Bauer
In: The Progress of Hydrology, Vol 2 - Specialized Hydrologic Subjects, Proceedings 1st International Seminar for Hydrology Professors, Jul 13-25, 1969. 33 p, 3 fig, 3 tab.

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Descriptors: *International hydrological decade, *Urbanization, *Storm runoff, *Rainfall-runoff relationships, Research and development, Mathematical models, Cost- benefit analysis, Water resources development, Hydrology, Hydraulics, Water quality control, Planning, Illinois.
Identifiers: *Water resources research, *Urban hydrology.

This paper presents viewpoints of a practicing consulting engineer concerning the following aspects of urban hydrology: the controlling economic factors; the need for improved analytical and design techniques; and the use of simplified methods pending the gathering of data required for the use of improved techniques. The northeastern Illinois metropolitan area is used as an example in illustrating each of these aspects. Storm runoff in urban areas takes up valuable space, and only the location of this space is subject to engineering control. Therefore it is the volume of runoff more than the rate of runoff which is important to evaluate for design purposes. Runoff from urban areas presents a quality control problem. Therefore it behooves the planner to move in the direction of large storage and small rates of flow, because of the high cost of treatment at high rates of flow for short periods of time. All methods of analysis of storm runoff and the associated flow in open channels involve the use of mathematical models. Every decision regarding storm drainage, even one to do nothing, involves an allocation of space for the temporary storage of storm water, and therefore involves an acceptance of the cost associated with that decision.

188
DETERMINATION OF STORM RUNOFF BY THE USE OF INFILTRATION INDEX,

A. Bhatnagar
In: Floods and Their Computation, Vol 2, International Association of Scientific Hydrology Publication No 85, pp 804-810, 1969. 3 fig, 1 tab, 4 ref.

Descriptors: *Storm runoff, *Streamflow forecasting, Interception, Water storage, Infiltration, Antecedent precipitation, Rainfall, Duration curves, Discharge (water), Hydrograph analysis, Depth-area-duration analysis, Storms.
Identifiers: India.

Storm runoff can be estimated quite accurately by an estimate of interception, retention, and an infiltration index which includes other minor losses such as evaporation and transpiration. Hydrological data of 17 representative catchments in Central India were analyzed to estimate initial losses and infiltration indices occurring during storms. A coaxial relation between infiltration index, the antecedent precipitation index, storm rainfall, and storm duration has also been evolved for the region. If storm duration, storm rainfall, and antecedent precipitation conditions are known, the infiltration index during a storm on a catchment in this region can be determined. Storm runoff can then be estimated by subtracting initial loss and infiltration index from storm rainfall rates.

189

MEASUREMENT PROCEDURES FOR THE PLANNING OF SEWER SYSTEMS,

Ernst Billmeier
Ber Inst Wasserwirt Gesundheitsingenieurwesen, No 4, pp 1-185, 1970.

Descriptors: *Sewers, *Sewerage, *Measurement, *Planning, *Storm runoff, *Storm drains, Drainage.
Identifiers: *Parametrics, Hydraulic calculations.

The measurement procedures available for the calculation of three types of storm drains in mixed and separate systems contradict recent findings and should no longer be used. The author has attempted to incorporate storm water drainage parameters into more recent measurement procedures with the view of drawing diagrams for practical application. The use of these diagrams is demonstrated on several examples. A comparison of calculation procedures for the various storm drain types brought to light their respective differences and served as a check on the suitability for their dimensioning. Hints concerning the construction of such drains are offered.

190

INFLUENCE OF WOODS ON FLOOD RUN-OFFS FROM MELTINGS OF THE SNOW,

H. M. Brechtel and Hann Muenden
Wasser Boden, Vol 23, No 3, pp 60-63, Mar 1971. 1 fig, 1 tab, 5 graph, 2 ref.

Descriptors: *Snowmelt, *Runoff, *Forests, *Floods, *Measurement, Investigations.
Identifiers: *Germany.

The influence of forests on snow accumulation and melting snow was studied in the Vogelsberg area, which is watered by the river Nidda. Measurements were taken at 7 altitudes, 100-700 m above the Nidda, in a beech and spruce forest and in an open field. Beginning in January 1970, the water equivalent of the snow cover was measured each Thursday at 42 different levels. The probe used for the measurements was 1.20 m long with a mass of about 1100 g. It consisted of an acrylic glass or PVC tube with a rim of stainless steel. The tube was constructed so that snow was not compacted by the sampling process. The water equivalent in a snow cover can be suddenly liberated by a downpour of rain. Under such circumstances, the melted snow water flows off rapidly to the main sewer. The presence of low-level coniferous forests can reduce the quantity of flood runoff through high interceptive evaporation. Forests located in higher altitudes prevent snow drifting down to lower levels, yet provide an enormous pool of snow water thus increasing flood danger.

191

FORECASTING THE VOLUME OF STORM RUNOFF USING METEOROLOGICAL PARAMETERS,

Robert Hasbrouck Cartmill
University of Oklahoma Thesis, 1970.

Descriptors: *Runoff forecasting, *Storm runoff, *Methodology, Meteorological data, Analysis, Measurement, Instrumentation.
Identifiers: *Infiltration rate, Parametrics.

This work develops a method forecasting runoff volume without reliance on any empirically derived relationships between meteorological parameters and recorded runoff measurements. The method is therefore applicable to areas where there are no existing meteorological or hydrological records. This method determines the infiltration rate by use of an approximate solution to the soil moisture diffusion equation. This solution requires knowledge of the existing soil moisture content, the saturated soil moisture content, and the saturated hydraulic conductivity at all depths of the root zone. The variable amount of soil moisture in nine district layers of soil is determined daily by maintaining a water budget of the 51 inch layer of soil which is assumed to constitute the root zone. The water budget contains the factors of rainfall, interception losses, runoff, the redistribution of infiltrated rain soon after infiltration, drainage from each layer, and evaportranspiration. After the parameters required to determine the infiltration rate are available, the infiltration rate is compared with the rainfall rate every minute. The excess of rainfall over infiltration is then consigned first to depression storage and then to runoff. This method was applied to two major and thirteen smaller storms over a 208 square mile watershed in South Central Oklahoma. The runoff forecast by the method was compared with the measured runoff from the watershed. Conclusions are reached concerning the area of applicability of the method, the instrumentation required, and the limits of accuracy of the method.

192
COMPUTER SIMULATION OF URBAN STORM WATER RUNOFF,

Carl W. Chen and Robert P. Shubinski
J Hydraulics Div, Am Soc Civil Engrs, Vol 97, No HY2, pp 289-301,
Feb 1971. 9 fig, 1 tab, 12 ref.

Descriptors: *Hydraulic models, *Hydrography, *Hydraulics, *Runoff, *Computer programs, *Storm runoff, Overland flow, Open channel flow, Drains, Model studies, Simulation analysis.
Identifiers: *Urban hydrology.

As part of an overall storm water management program, a model was developed to simulate the runoff phenomena of a drainage basin for any given rainfall pattern. The model represents the basin by an aggregate of idealized subcatchments and gutters. The computer is instructed to make a step-by-step accounting of rainfall, infiltration, detention, overland flow, and gutter flow in the calculation of a hydrograph. Three preliminary simulations are made to demonstrate the validity of the method.

193
A RECURSIVE PROGRAMING MODEL FOR NONSTRUCTURAL FLOOD DAMAGE CONTROL,

John C. Day
Water Resources Res, Vol 6, No 5, pp 1262-1271, Oct 1970. 17 ref.

Descriptors: *Flood plains, *Flood damage, *Flood control, *Land use, *Urbanization, *Storm runoff, Land management, Economics, Design criteria, Computer programs, Model studies.

This paper deals with flood plain land use management approaches for urban flood damage control. These alternatives are important because traditional flood control projects, such as levees, channel improvements, and reservoirs, are not always capable of correcting the physical and economic conditions that give rise to flood damage. It is expected that land use management will complement engineering works and lead to a more effective use and development of flood plain lands. The paper presents a computational technique for evaluating alternative land use assignments based upon the economic value a community gains from its land. A linear programming model is developed that identifies economically efficient combinations of 1) spatial and temporal planning of urban land use, 2) site elevation through landfill, and, 3) flood proofing of buildings.

194
REAL-TIME COMPUTER CONTROL OF URBAN RUNOFF,

George Fleming and Robert L. McFall (discussion)
J Hydraulics Div, Am Soc Civil Engrs, Vol 96, No HY9, pp 1908-1909,
Sep 1970.

Original Paper: REAL-TIME COMPUTER CONTROL OF URBAN RUNOFF,
James J. Anderson
J Hydraulics Div, Am Soc Civil Engrs, Vol 96,
No HY1, pp 153-164, Jan 1970.

Descriptors: *Runoff, *Hydraulics, *Mathematical models, *Digital computers, Water management (applied).

Fleming: A method to calculate continuous runoff volumes preferred by the writer is to employ simulation techniques using the Hydrocomp Simulation Program which simulates the complete land phase of the hydrological cycle, and uses kinematic wave assumptions for flow in circular conduits. For purposes of the mathematical model a large scale computer could be assessed using the PDP-9 for data acquisition and control of automatic gates.
McFall: The writer would like to see a breakdown of costs into the categories of 1) capital outlay, 2) equipment operating, and 3) personnel cost.

195
WHERE IS URBAN HYDROLOGY PRACTICE TODAY?

D. Earl Jones
J Hydraulics Div, Am Soc Civil Engrs, Vol 97, No HY2, pp 257-264,
Feb 1971. 15 ref.

Descriptors: *Storm runoff, *Storm drains, *Runoff forecasting, *Hydraulics, Drainage, Drainage effects, Rational formula, Flood routing.
Identifiers: *Urban hydrology.

The evolution of urban street construction and its effects upon urban drainage is traced. Rational method development and inconsistencies in its application are summarized. The emphasis is on lack of absolute precipitation data with resultant inhibiting effects upon development of improved runoff prediction methods. Need for two drainage systems on each urban drainage area is defined. It indicates dual system dividends are reduced drainage costs, reduced flooding losses, and the opportunity to enhance property values, stabilize neighborhoods, and improve urban life quality. Some basic methods for managing urban runoff are also indicated to attenuate peak flows.

A low maintenance channel is identified as being more realistic than usual urban channel designs. It points out that direct losses from and expenditures for urban drainage approximate four billion dollars per year.

196

URBAN RUNOFF BY ROAD RESEARCH LABORATORY METHOD,

D. Earl Jones (discussion)
J Hydraulics Div, Am Soc Civil Engrs, Vol 96, No HY9, pp 1879-1880, Sep 1970.

Original Paper: URBAN RUNOFF BY ROAD RESEARCH LABORATORY METHOD,
Michael L. Terstriep and John B. Stall
J Hydraulics Div, Am Soc Civil Engrs, Vol 95, No HY6, pp 1809-1834, Nov. 1969.

Descriptors: *Runoff forecasting, *Hydrographs, Methodology.
Identifiers: *RRL method.

The writer states that the Road Research Laboratory method provides a basis for evaluation of potential drainage area responses without prior extensive collection of local urban streamflow records furnishing a simple rationale for estimating flow hydrographs. The RRL model seems advantageous from the standpoints of simplicity, ease of application, minimal data input requirements, and reasonable reliability of results in the common application range.

197

FLOOD STATISTICS: COMMENT ON "RELATIVE DISCHARGE HYDROGRAPHS, ITS COMPUTATION AND APPLICATION FOR DETERMINATION OF THE PROBABILITY OF FLOOD RUN-OFF",

H.-B. Kleeberg (discussion)
Wasser Boden, Vol 23, No 2, pp 34-35, Feb 1971. 2 tab, 2 graph, 1 ref.

Descriptors: *Floods, *Hydrographs, *Runoff, *Flood forecasting, *Runoff forecasting, Statistics, Parametric hydrology.

Lehman's method of using relative flood runoff characteristics to determine flood runoff is not acceptable for the following reason: no general parameters for characterization of various flood events can be assumed. This is also true for so-called universal methods of determining flood frequency. The peak discharge of a flood is influenced by the path of the wave. Special consideration must be given to the individual runoff properties of natural waters which are influenced by physical conditions. The application of estimated formulas which make no allowance for error and which have no objective initial parameters is not acceptable. Present and past measurement results cannot be combined if the external conditions have changed. Prior to determining the flood peak discharge by the relative flood runoff characteristics, the suitability of the individual situation must be checked.

198

SURFACE RUNOFF FROM GRADED LANDS OF LOW SLOPES,

J. M. Laflen and I. L. Saveson
Trans, Am Soc Agr Engrs, Vol 13, No 3, pp 340-341, 1970. 4 fig, 2 ref.

Descriptors: *Mathematical studies, *Data collections, *Surface runoff, Estimating equations, Storms, Louisiana.
Identifiers: *Data analysis.

This paper reports on analysis of surface runoff data collected during 1962, 1963, and 1964 near Baton Rouge, La. The object of the data analysis was to develop reliable prediction equations for estimating peak rate and total amount of surface runoff from any storm. The hypothesis tested was that peak rate and total amount of surface runoff could be expressed as functions of precipitation, row slope, row length, and antecedent soil moisture. Some conclusions drawn from the experiment include: 1) the effect of antecedent soil moisture is independent of precipitation, if the peak rate of runoff is the dependent variable; 2) the effect of slope and length of surface runoff is not independent of precipitation; 3) a single, precipitation - intensity measure is sufficient for expressing the effect of precipitation on peak rate of surface runoff.

199

A METHOD FOR RUNOFF-MAPPING FROM PRECIPITATION AND AIR TEMPERATURE DATA,

H. Liebscher
In: Symposium on World Water Balance, Vol 1, No 92, pp 115-121, Jul 1970. 3 fig, 8 ref.

Descriptors: *Water balance, *Mapping, Rainfall-runoff relationships, Data collections, Data processing, Maps, Hydrologic cycle, Runoff, Streamflow.
Identifiers: *West Germany.

A simple method is given for obtaining runoff maps from precipitation and air temperature data. It has proven of considerable practical value in the Federal Republic of Germany. The procedure can also be used for determining the long-term depth of runoff in areas for which runoff data are not available. Of all related factors, precipitation is the one that exerts the strongest influence on mean runoff depth and specific yield. If approximate evapotranspiration values for all stations concerned have been determined from precipitation and air temperature data, it is possible to get from the difference between precipitation and evapotranspiration approximate information on long-term mean runoff depth or specific yield. With the aid of the maps thus obtained, it is easy to determine the values required for water balance by plainmetering the areas between the isolines.

200
EXAMINATION OF RAIN WATER LOSS MECHANISM IN AN URBAN AREA,

Shigeaki Matsubara and Masai Yokoo
In: Proceedings of the Seventh Conference on Sanitary Engineering Research, Japan Society of Civil Engrs, Committee on Sanitary Engineering, Jan 30-31, 1971. 157 p.

Descriptors: *Infiltration, *Discharge (water), *Rainfall-runoff relationships, Data collections, Investigations, Water loss, Mathematical studies, Forecasting.
Identifiers: *Urban hydrology, Quantitative analysis, Japan.

In an urban area, surface conditions characterized by infiltration and non-infiltration areas are considered to be the significant factors that control the outflow phenomena. Weak rainfall in an urban area results in outflow from the non-infiltration area, and strong rainfall in the combination of outflows of both infiltration and non-infiltration areas. Based on the data obtained during an investigation on the rainwater outfall in an urban area, outflow coefficients and water losses are calculated. Futhermore, through quantitative analysis various mathematical formulations are examined. It is concluded that although mathematical tools such as the peakflow quantity formula will continue to be used in the future, further improvements are necessary to allow more accurate forecasting and to obtain more precisely the loss mechanism in an urban area.

201
RUNOFF - A POTENTIAL RESOURCE,

Eric F. Mische and Vishnu V. Dharmadhikari
Water Wastes Eng, Vol 8, No 2, pp 28-31, Feb 1971. 4 tab, 10 ref.

Descriptors: *Storm runoff, *Urbanization, *Research and development, Water pollution sources, Water quality, Sampling, Monitoring, Water treatment, Water reuse, Water resources, Water quality control.
Identifiers: *Urban hydrology.

The Water Resources Research Center and the Department of Civil Engineering at the University of Arizona have jointly undertaken a broad research effort that relates to the field of urban hydrology. This research has three general objectives involving both the quantitative and qualitative aspects of urban runoff. The results of only one phase of this study are presented in this article. Samples of runoff from three urban, natural watersheds of differing characteristics were analyzed in order to provide a basis for the evaluation of potential pollution effects and to initiate exploratory studies of treatment methods. In the absence of automatic sampling devices, grab samples were collected manually and used for analyses of ions, suspended and organic matter, and bacterial densities. The quality of water generally varied slightly from sample to sample in a given storm and between different storms. It was observed that as the area becomes more developed the turbidity reduces. Results of suspended solids analyses follow a pattern similar to that of the reported turbidity findings. Data indicate that predominantly residential areas are not likely to contribute large amounts of TDS (total dissolved solids). The pollutional strength results, measured by the COD test, indicate that residential and commercial areas contribute approximately the same COD to runoff, while higher values were obtained from the waters in the industrialized watershed. It was shown that the removal of suspended solids alone greatly enhances the potential reuse of runoff waters. The study demonstrated that in human fecal material and in domestic wastes, fecal coliforms exceed the fecal streptococci by a ratio of 4 to 1. It is concluded that coagulation of urban runoff is effective; however, in reclaiming urban runoff, a sludge handling and disposal problem will result.

202
THE CONTRIBUTION OF RAIN RUNOFFS TO WATER POLLUTION,

Wilhelm J. Muller
Gas- Wasserfach (Wasser/Abwasser), Vol 112, No 1, pp 15-17, Jan 1971.

Descriptors: *Runoff, *Precipitation intensity, *Water pollution sources, Urbanization, Rainfall, Suspended load, Storm runoff.
Identifiers: *Germany.

In the Federal Republic of Germany the median precipitation (forty-year average from those measured between 1891 and 1930) is 803 mm/year. Of this 365 mm or 45.5% reach the ocean as direct runoff or

indirect runoff or as wastewater. The runoffs carry along numerous substances in solved or suspended form. For assessment of the contribution of rain runoffs to water pollution, the runoffs from residential and industrial areas are of concern. Urban areas span 9.6% of the total surface on the Federal Republic. The rain runoff from these areas has been determined with 10,140 million cbm/year. They carry street dust, manure, leaves, abrasions from street pavements and rubber tires of vehicles, oil and fuel lost by vehicles, and other inorganic matter. The content of suspended matter is particularly high. The BOD ranges on an average of between 10 and 30 mg/liter. From tar and asphalt pavements carcinogenic matter is carried along. The great disadvantage of rain runoffs is that they burden the waterways spasmodically. With progressing urbanization it will become necessary to collect the rain runoffs and purify them before they can be entered into waterways.

203

RUNOFF GROUPING FOR DETECTION OF CHANGE IN RUNOFF,

Hiroshi Nakamichi and Hubert J. Morel-Seytoux
J Irrigation Drainage Div, Am Soc Civil Engrs, Vol 97, No IR 2, pp 175-290, Jun 1971. 2 fig, 2 tab, 12 graph, 20 ref.

Descriptors: *Colorado, *Colorado River, *Hydrology, *River basins, *Runoff, *Rainfall, *Rainfall-runoff relationships, *Cloud seeding, *Hyetographs, *Analytical techniques, Regression analysis.
Identifiers: *Precipitation management, *Grouped basins.

This study was prompted by the Bureau of Reclamation to conduct a pilot project of precipitation management in the southern part of the Rocky Mountains, within the state of Colorado, and by a need to develop techniques for rapid detection of significant hydrologic changes. Analysis of the Upper Colorado River Basin, its hydrology, rainfall-runoff relationships, the effect of cloud seeding on runoff, and the suitability of grouped basins for study are detailed. This paper shows the value of grouping stations in an optimized manner to minimize the time needed for evaluation of a change in runoff, and that significant evaluation of the change in runoff can be obtained within the planned duration of the Bureau's project provided that a 20% increase in winter precipitation is achieved.

204

STATISTICAL RELATIONSHIP BETWEEN STORM AND URBAN WATERSHED CHARACTERISTICS,

V. V. Dhruva Narayana, M. Akbar Sial, J. Paul Riley, and Eugene K. Israelsen
Completion Report PRWG 74-2, Aug 1970. 55 p, 11 fig, 15 tab, 47 ref, 2 append.

Descriptors: *Storm runoff, *Forecasting, *Drainage, *Watersheds (basins), Hydrology, Surface runoff, Illinois, Urbanization.
Identifiers: *Statistical hydrology, *Flood frequency, *Urban drainage, Urban hydrology, Urbana, Illinois, Boneyard Creek, Illinois.

Because of the rapid urban development in recent years, hydrologic problems associated with urban watersheds have gained importance. Large sums of money are being spent for the design of urban drainage systems based upon inadequate procedures for predicting peak runoff rates. A procedure is proposed for predicting peak runoff rates from small urban and rural watersheds based upon measurable storm and watershed characteristics. The technique was tested for a number of runoff events on the Boneyard Creek watershed at Urbana, Illinois, and the results of this test are included. The procedure will be particularly useful for estimating runoff rates from small ungaged drainage areas, and thus will be directly applicable to both design and water management problems.

205

AUXILIARY TABLES FOR THE HYDRAULIC CALCULATION OF OPEN ARTIFICIAL DRAINAGE DITCHES,

Rolf Pecher
Ber Inst Wasserwirt Gesundheitsingieurwesen, No 1, pp 1-17, 1969. 4 ref.

Descriptors: *Mathematical studies, *Drainage systems, *Ditches.
Identifiers: *Hydraulic calculations, *Flow velocity, *Drainage volume.

In accordance with ATV guidelines, the Gauckler-Manning-Stickler velocity equation and the Stickler velocity coefficient are used in the calculation of drainage ditches. The flow velocity and drainage volume are determined for the standard ditch profiles listed in DIN 19 556, evaluated for a gradient equalling 10 pro mille and for a velocity coefficient of 70 m 1/3/s and arranged in the form of tables. The conversion for any gradient and for any ditch wall profile is accomplished by means of conversion factors listed in a separate table. Drainage quantities and flow velocities as a function of the gradient and of filling depth for triangular ditches with a 90 or 60 degree base angle for the velocity coefficient of 70 m 1/3/s are listed in table form. Drainage volume and flow velocity for other velocity coefficients are determined with the help of conversion factors.

206
THE DRAINAGE COEFFICIENT AND ITS DEPENDENCE ON THE DURATION OF RAIN,

Rolf Pecher
Ber Inst Wasserwirt Gesundheitsingenieurwesen, No 2, pp 1-140, 1969.
151 ref.

Descriptors: *Storm runoff, *Mathematical studies, *Drainage, Rain water, Sewerage.
Identifiers: *Hydraulic calculations.

The storm water drainage process is analyzed and theoretical criteria are derived which permit a mathematical treatment of the process. The calculation takes into account losses caused by wetting and depressions, the surface incline, seepage as a function of time, type of soil, soil humidity and plant cover evaporation, and the duration and migration velocity of rain. The peak drainage coefficient and the median drainage coefficient are a function of the duration of rain. The three phases of drainage are its beginning, the rise of the floodwave, and its following the start of rain. The drainage coefficient is obtained through division of the drainage surfaces into permeable and impermeable partial areas by considering their wetting, depression loss, and seepage characteristics. The peak and median drainage coefficients which can be calculated as a function of rain yield, duration, and frequency are not constant. The drainage coefficient, when introduced into the calculation of sewage systems, will yield more accurate data.

207
THE DIMENSIONING OF STORM DRAINS IN URBAN DRAINAGE SYSTEMS,

Rolf Pecher
Ber Inst Wasserwirt Gesundheitsingenieurwesen, No 3, pp 1-98, 1970.

Descriptors: *Storm drains, *Storm runoff, *Drainage systems, *Cities, *Rain water, Overflow, Reservoir storage, Basins.
Identifiers: *Hydraulic calculations.

Storm drains include rain retention reservoirs, storm water clearing basins, and storm water overflow basins. A new method of calculating storm drains of all three types is outlined. In the case of rain retention reservoirs the calculation method provides for variable drainage depending on the degree of filling, it can be adapted to any rain frequency and yields somewhat higher results than the Mueller-Neuhaus and the Lautrich graphic methods. The calculation of storm water clearing basins is predicated on an assumed retention time of between 10 and 20 minutes and on a stipulated clearing effect. The calculation of storm water overflow basins meets the condition that these not overflow until a critical rain level is reached (which condition is not met by the alternative Londong method).

208

A METHOD FOR CHARACTERIZING THE RUNOFF POTENTIAL OF RAINFALL IN WATER HARVESTING SCHEMES,

E. Rawitz and D. Hillel
Water Resources Res, Vol 7, No 2, pp 401-405, Apr 1971. 2 tab, 4 graph, 8 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff forecasting, *Storms, Methodology, Infiltration, Rainfall disposition, Rainfall intensities, Distribution patterns.
Identifiers: *Israel.

The ever increasing world demand for water has renewed interest in the development of efficient runoff inducement techniques. Often only scanty hydrologic data are available for planning purposes, and the amount of runoff obtainable can be predicted only on the basis of the prevailing rainfall pattern of a given location. The authors have developed a method for evaluating the runoff producing potential of rainfall patterns and for estimating the amount of water hypothetically obtainable from water harvesting areas of given average infiltration rates. Data obtained from the arid zone of Israel indicate that the distribution of rainfall amounts in relation to rainfall intensities is skewed toward the low intensities and that a few large storms generally account for most of the total rainfall and runoff producing potential. A scaling of rainfall intensity versus relative rainfall amount (fraction of each season's total) shows that seasons with widely different total rainfalls nevertheless have similar relative distribution patterns. This fact suggests the possibility of finding a function that can adequately characterize the relative intensity distribution pattern of a region and can be used to predict runoff potential in relation to seasonal rainfall probabilities.

209

SIMPLIFICATION OF INTEGRATED STORMWATER PLANNING FOR MODERN MULTIPLE LAND USE IN URBAN AND SUBURBAN DEVELOPMENTS,
Pennsylvania State University, University Park. Inst for Research on Land and Water Resources

Brian M. Reich
Mar 1970. 62 p. W70-07981, OWRR-B-010-PA(1), Contract DI-14-01-0001-1046.

Descriptors: *Hydrology, *Storms, Design, Drainage, Storage, Hydrographs, Watersheds.

Four synthetic hydrograph methods were applied on five watersheds in hopes of simplifying planning decisions for reserved space in valley bottoms of suburbia headwaters. Both hydrograph and routing procedures were programmed for digital computer evaluation for the more than 300 cases considered. General conclusions include the following: 1) no simple rules can be given on width of floodways to planners; 2) computer methods greatly facilitate routing and synthetic hydrograph computations; 3) a great need exists for data-based methods for predicting suburban design hydrographs in ungaged situations; and 4) a new course was developed on urban hydrology based on the studies results.

210

STORM RUNOFF FROM CHAPARREL WATERSHEDS,

Raymond Martin Rice
Dissertation, 1970. 162 p.

Descriptors: *Hydrographs, *Runoff, *Storm runoff, Storms, Watersheds (basins), Rainfall.
Identifiers: *Canonical correlation, *Multiple regression.

Canonical correlation and multiple regression were used to predict runoff hydrographs from rainstorms on brush covered watersheds. The data used to develop the prediction equations were collected on the San Dimas Experimental Forest over a period of 21 years. They included 262 hydrographs representing the runoff from as many as 15 drainage basins during 35 storms. The resulting prediction equations were tested on 15 hydrographs from two watersheds and 34 storms. The similarity of predicted hydrographs based on multiple regression and canonical correlation analyses led to an inquiry which demonstrated that, when all canonical roots are used, multiple regression and canonical correlation are mathematically equivalent. Fifteen independent variables described the watershed condition and rainfall related to each of the hydrographs. Objective criteria were developed to appraise the utility of the independent variables and the adequacy of sets of canonical correlations. For the study area it was found that the watershed physiography was not strongly related to runoff hydrographs. Prediction equations were greatly degraded by the arbitrary removal of either variables describing the vegetation and antecedent moisture of the watershed or variables which described the storm causing the runoff hydrograph. The lack of congruence between the observed and predicted hydrographs was mainly due to poor estimation of the peak discharge.

211

EFFECTS OF URBANIZATION ON RUNOFF FROM SMALL WATERSHEDS,

Puranam Bhaskara Seshardri Sarma
Dissertation, 1970. 307 p.

Descriptors: *Rainfall-runoff relationships, *Urbanization, Investigations, Analysis.
Identifiers: *Urban hydrology, Parametrics.

Urban and suburban development changes the quantity and time distribution of runoff. Investigation of the effect of urban development on the rainfall-runoff relationships was the main objective of this study. Quantitative evaluation of effect of urbanization on runoff would be relatively simple if rainfall and runoff data for both urban and pre-urban conditions of watersheds were available. Due to a lack of availability of such data, evaluation of changes in runoff characteristics caused by urbanization is not possible by direct data comparison and analysis. Data for the study were obtained principally from watersheds in West Lafayette, Indiana. Hydrologic data from several other urbanized watersheds were also used to make the study more general. The linear system analysis was used in the study. The single linear reservoir model, the double routing method, Nash model, the single linear-reservoir linear-channel model, and the Fourier transform method of obtaining the kernel function were used in the analysis of data. The parameters of the instantaneous unit hydrographs for the first four models were determined and also optimized for some of the conceptual models. Similarly, the kernel functions were determined by the Fourier transform method. The regeneration performance of all these models was then tested. The single linear reservoir model was selected to simulate the rainfall-runoff process on small urban watersheds. On the basis of its satisfactory regeneration performance and some other factors, the Nash model was similarly selected for simulation of the rainfall-runoff process on larger watersheds. The parameters of the single linear reservoir model and the Nash model were then studied in detail. The variation of the parameters and their relationships with the physiographic characteristics of the watersheds including the urbanization factor, and the storm characteristics, were studied mainly by using the techniques of regression analysis. From this analysis, the effects of urbanization on time lag, the magnitude of peak discharge, the time to peak discharge, and the frequency of peak discharge were quantitatively deduced.

212

PROBABILITIES FOR SIMULTANEOUS OCCURRENCE OF FLOODS IN THE DANUBE AND INN RIVERS BEFORE AND AFTER COMPLETION OF STRUCTURES IN THE DANUBE RIVER,

Gert A. Schultz
Wasserwirtschaft, Vol 9, pp 293-296, 1970. 9 fig, 1 tab, 6 ref.

Descriptors: *Floods, *Flooding, *Flood forecasting, Synthetic hydrology, Hydraulic structures.
Identifiers: *Danube River, *Inn River.

The flood statistics for the city of Passau reveal that whenever one of these two rivers carried a flood wave the other produces a flood several days after. The Danube peak usually follows the Inn peak. Based on 67 independent flood events between 1926 and 1967, the probability for the "critical case" (the simultaneous occurence of flood peaks of the Danube and Inn Rivers' confluence) has been investigated and reported herein. An attempt has been made to estimate the influence of hydraulic structures in the Danube river upstream of the confluence on the "critical case" probability. If this influence can be determined then it is possible to investigate the future tendency of a synthetic flood frequency analysis for the Danube river downstream of the confluence.

213

PRELIMINARY ANALYSIS OF RATE OF MOVEMENT OF STORM RUNOFF THROUGH THE ZONE OF AERATION BENEATH A RECHARGE BASIN ON LONG ISLAND, NEW YORK,

G. E. Seaburn
In: Geological Survey Research 1970, Chapter B, pp B196-B198, 1970.
3 fig, 1 tab, 2 ref.

Descriptors: *Infiltration, *Artificial recharge, Groundwater movement, Storm runoff, Urbanization, Cities.
Identifiers: *Long Island, New York.

A study of recharge basins on Long Island has provided information on the rate of movement of water through the zone of aeration. Pertinent data were collected during 38 storms from a basin in Central Nassau County, where the depth to the water table is 35 ft below the bottom of the basin. In this basin the apparent downward rate of movement averaged 5 feet per hour; it ranged from an average of 3 feet per hour for storms in November through March to an average of 6 feet per hour for storms in April through October.

214

DATA ERROR EFFECTS IN UNIT HYDROGRAPH DERIVATION,

Krishan P. Singh (discussion)
J Hydraulics Div, Am Soc Civil Engrs, Vol 96, No HY7, pp 1633-1636,
Jul 1970. 1 tab, 2 ref.

Original Paper: DATA ERRORS EFFECTS IN UNIT HYDROGRAPH DERIVATION,
Eric M. Laurenson and Terence O'Donnell
J Hydraulics Div, Am Soc Civil Engrs,
Vol 95, No HY6, pp 1899-1917, Nov 1969.

Descriptors: *Unit hydrographs, *Methodology.
Identifiers: *Error analysis, *Data analysis.

The author comments upon the analysis of the errors of the first three of the four methods of unit hydrograph derivation studied in the original paper: (1) Laguerre Functions Method (LFM); (2) Harmonic Series Method (HSM); (3) Least Square Method (LSM); and (4) Gamma Distribution Method (GDM); when the basic data (the hyetograph and hydrograph) were in error. The mean errors, as a percentage, for the four methods of derivation using error-free data are presented in a table. Errors due to functional structure and flexibility of the methods are demonstrated. Further investigation is suggested concerning the fact that the derived unit hydrographs will differ more from the true ones for smaller durations of rainfall excess and errors in data.

215

DESIGN RAINFALL CHARACTERISTICS OF THE USSR TERRITORY,

E. A. Smirnova
In: Floods and Their Computation, Vol 1, No 84, pp 105-114, 1969.
2 fig, 3 tab, 3 ref.

Descriptors: *Design storm, *Hydrograph analysis, *Rainfall-runoff relationships, Rainfall intensity, Statistical methods, Hyetographs.
Identifiers: *USSR.

A method of processing hyetographs to obtain design rainfall characteristics used in maximum storm runoff computation is summarized. The technique provides, for a homogeneous climatic region: (1) the plotting of a curve of maximum depth increase with time interval increase and (2) the plotting of a curve of mean rainfall intensity decrease with time interval increase for certain exceedence or frequency probabilities. Depth of rainfall intensity for a required time interval can be determined for any point with known daily rainfall. Ordinates of reduction curves are only slightly dependent on frequency and change slowly. Curves of rainfall reduction have been plotted for different physiographical regions of the USSR and characteristics of the main types of reduction curves and their territorial distribution are given.

216
URBANIZATION AND THE WATER BALANCE,

Andrew M. Spieker
In: Proceedings of Symposium on Water Balance in North America, Jun 23-26, 1969, Alberta, Canada, American Water Resources Assoc, Urbana, Illinois, pp 182-187, 1969. 2 fig, 8 ref.

Descriptors: *Urbanization, *Rainfall-runoff relationships, *Water pollution sources, Cities, Time lag, Sediment load, Waste disposal, Floods, Hydrographs, Peak discharge.
Identifiers: Urban hydrology, North America.

Urbanization modifies the hydrologic balance by causing changes in the distribution and quality of water in time and place. The overall quantity of water, however, remains essentially unchanged. In extreme cases, the lack of adequate management measures can result in catastrophic events. Several examples are cited. In 1969 floods in southern California were intensified by uncontrolled urban sprawl in alluvial fans and canyons. Sewering of urbanized areas on Long Island has caused an increase in direct runoff and flood peaks, and a lowering of groundwater levels. Detailed studies of storm runoff in Fairfax County, Virginia, have shown that urbanization in small watersheds increases peak flow by 2 to 3 times, and shortens the lag time by about 8 times. Intensive construction in urbanizing areas can result in sharply increased sediment loads in streams and lakes. Chemical and bacterial quality of water are also affected by urbanization. Studies of Salt Creek, a small stream in suburban Chicago, indicate high coliform and BOD levels at both low and high flows. Coliform counts are greater at high flows, resulting from combined sewer overflows.

217
SOME EFFECTS OF URBANIZATION ON FLOODS,

John B. Stall, Michael L. Terstriep, and Floyd A. Huff
Meeting Preprint 1130, a paper presented at the ASCE National Water Resources Meeting, Memphis, Tenn, Jan 26-30, 1970. 29 p, 11 fig, 10 tab, 22 ref.

Descriptors: *Surface runoff, *Storm runoff, *Rainfall-runoff, relationships, *Peak discharge, *Urbanization, Hydrographs, Model studies, Floods, Illinois.
Identifiers: Design flood.

The objectives of the study were: (1) to attempt a better definition of the effects of urbanization on floods by using relatively good information available in Illinois on storm rainfall structure and frequency, and (2) to translate this into the resulting effect on the flood-frequency curve using a set of empirical equations developed in 1965 at the University of Texas Center For Research in Water Resources. The Texas equations were used as a transfer function from storm rainfall to flood peak. A model two-hour rainstorm, based on recorded precipitation data from East-Central Illinois, was developed for various recurrence intervals and applied to the completely urbanized, 3.5-square mile drainage area of Boneyard Creek at Urbana, Illinois. The specified model storm was applied to the derived unit hydrographs after determining the rainfall excess after losses. The empirical Texas equations seem adequate to produce a 30-minute unit hydrograph for the Boneyard basin and it checks favorably with actual unit hydrographs. The complete transformation of a 3.5-square mile rural basin, in East-Central Illinois, to an intensely urbanized basin would quadruple the flood peak for the 50-year recurrence interval; and the mean annual flood would increase by about eight times.

218
URBAN RUNOFF BY ROAD RESEARCH LABORATORY METHOD,

Leonard H. Watkins, Franklin F. Snyder, Harvey W. Duff, and George C. C. Hsieh (discussion)
J Hydraulics Div, Am Soc Civil Engrs, Vol 96, No HY7, pp 1625-1631, Jul 1970. 2 tab, 4 ref.

Original Paper: URBAN RUNOFF BY ROAD RESEARCH LABORATORY METHOD,
Michael L. Terstriep and John B. Stall
J Hydraulics Div, Am Soc Civil Engrs, Vol 95,
No HY6, pp 1809-1834, Nov 1969.

Descriptors: *Hydrographs, *Runoff coefficient, *Evaluation, Runoff, Rational formula, Storm runoff.
Identifiers: *RRL method, *Urban runoff.

The authors separately discuss aspects of the article included in a previous issue on an application of the Road Research Laboratory method (RRL) for synthesizing urban runoff hydrographs to conditions at three locations in the United States. Leonard Watkins describes the use of this method in Great Britain, concluding that the amounts of runoff found by the American authors agreed with experience in Great Britain. Frank

Snyder discusses the theoretical applicability and other features of the RRL method, and he concludes that more analysis is needed in regard to the assumption of a constant runoff coefficient equal to the percentage of impervious area connected to a storm drainage system. He also states that the applicability of the RRL method to urban basins with pervious and unconnected impervious areas for infrequent design storms is limited. Harvey Duff and George Hsieh compare the commonly-used rational method to the RRL method for predicting urban runoff. The RRL method seems to result in more accurate inflow predictions, but both methods predict runoff accurately. The rational method appears easier to use; and when the RRL method is tried, a shorter time increment is recommended.

219
MEAN ANNUAL RAINFALL/RUN-OFF RELATIONSHIP,

L. H. Young
J Ind Water Engrs, Vol 24, No 7, pp 423-430, Oct 1970. 1 fig, 3 tab.

Descriptors: *Rainfall-runoff relationships, *Cities, Analysis, Water loss.
Identifiers: *Urban hydrology.

World wide data are analyzed to investigate the relationship between the mean annual runoff, rainfall, and temperature of cities. Other parameters considered are found to have little independent effect. For non-arid climates the relationship is a straight line for which the slope is unity for 50 degrees F, steeper for lower temperatures, and flatter for higher temperatures. Water loss is found to be independent of rainfall only in the region of 50 degree F. A general runoff formula is developed for the overseas data, and a separate formula for the British Isles.

SECTION 10.

Tunnels: Technology and Equipment

220
MACHINE TEAM MAKES SHORT WORK OF A LONG TUNNEL REACH,

Construct Methods Equip, Vol 53, No 1, pp 62-63, Jan 1971.

Descriptors: *Tunnels, *Tunnel construction, *Tunneling machines, Tunnel linings, Concrete construction, Tunnel hydraulics, California.
Identifiers: Tunneling shield.

Averaging 745 feet/week during the final 20 weeks of the 17,000-ft first-stage bore, miners driving a 22-ft diameter water tunnel 5 1/2 miles in soft dry sandstone under suburban Los Angeles recently holed through into a gate shaft and hall. Two machines made it possible to maintain the rapid pace through the tunnel's initial long reach: the tunneling shield, and a special tunnel-liner precasting jumbo that turned out 4-ft-long concrete liner segments at a clip of 12 per hour over an 80-hour week to support the shield's 144-hour weekly operation. The hydraulically powered shield, designed to make 8 feet per hour through ground similar to that encountered in the San Fernando bore, has a sliding boom with a total 11 ft of forward reach in two stages. The front of the shield is a cutting edge studded with teeth, and loss of top and center ground support causes material from the tunnel face to fall into a muck apron where it is dragged by the boom-head to a belt conveyor. The shield's hydraulic system is powered by electric motors that provide: 480 hp on the excavator functions, 160 hp on the shove jacks, 100 on the conveyor, and 60 on the erector. A laser and target guidance system keeps the shield on line, with the 5,000-psi jacks acting in unison within each quadrant to control alignment.

221
CUSTOM DESIGNED SHIELD LEAVES NO SPACE BEHIND AS IT SETS TUNNEL RINGS,

Construct Methods Equip, Vol 52, No 8, pp 64-67, 70, 72, Aug 1970.

Descriptors: *Drilling, *Tunnel construction, *Tunneling machines, Tunnel design.
Identifiers: *Tunneling shield, *Mexico.

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A tunneling shield used to drive a 30-ft diameter bore at shallow depths in soft, unstable ground, was designed to progress through drive cycles without leaving an annular space behind the shield after the shove had been made. The tunnel was driven up a constant incline having profile variations of from 0.8 to 7% at depths ranging from 52½ feet to 16 feet below street level. Guidance made use of a laser and target system; excavation was performed by a dozen miners working from the shield's six breasting tables with pneumatic spades and rock breakers. A description of the tunneling cycle is given.

222
VENTILATING A SEWAGE TUNNEL,

Heating Ventilating Engr, Vol 44, No 523, p 410, Feb 1971. 1 fig.

Descriptors: *Sewers, *Ventilation, *Maintenance, Tunnel technology.
Identifiers: Great Britain.

The Bournemouth Corporation uses two 36 inch fans capable of providing a duty of 28,000 cu ft/min at a pressure of 3.5 inches s.w.g. to ventilate a large underground coastline sewer. The ventilation allows work to be carried out in the sewer indefinitely under normal working conditions, and eliminates condensation problems for drying cement in the sewer.

223
TUNNEL TO BE CUT BY ELECTRON-BEAM MACHINE,

Machine Design, Vol 43, No 5, pp 18, Feb 1971.

Descriptors: *Electronic equipment, *Rock excavation, *Tunneling, *Tunneling machines.

An electron-beam machine design for rock excavation will be field tested during the Spring by Westinghouse. This electron-beam method has the potential of reducing the cost and increasing the speed of drilling and tunneling by making use of a high-energy electron beam that melts deep but narrow cuts in rocks. In the process, the rock-cutting beam is passed through a series of small chambers which are pumped to preserve a partial vacuum, focused electromagnetically, and delivered to the surface where it is needed.

224
RESEARCH AND DEVELOPMENT RELATED TO TUNNELING,
Organization for Economic Co-Operation and Development, Paris,
France

In: Advisory Conference on Tunneling of the Organization for Economic Co-Operation and Development, Aug 1970. 108 p.

Descriptors: *Tunneling, *Research and development, Construction, Underground structures.
Identifiers: Questionnaire.

The document is concerned with the status of applied research and development relating to tunneling technology. Applied research and development means theoretical and experimental studies of new design methods and construction techniques, including studies of the properties, character and behavior of tunnel structures, and of the ground mass in which they are constructed.

225
DEVELOPMENT OF TUNNELING METHODS AND CONTROLS,

Ellis L. Armstrong
J Construct Div, Am Soc Divil Engrs, Vol 96, No CO2, pp 99-118, Oct 1970. 16 fig, 2 tab, 1 ref.

Descriptors: *Tunneling, *Tunnels, *Surveys, *Costs, *Safety, Tunnel construction, Drilling, Drilling equipment, Tunneling machines, Rock bolts.
Identifiers: *Tunneling methods, *Tunneling controls, Concrete lining, Laser beams.

Improvement in methods and equipment during the past 15 years have kept tunnel excavation costs from appreciable increases while the general construction cost index has doubled. Tunnel drilling rates have increased from 20 ft per week 100 years ago to 100 ft per week 50 years ago and to about 300 ft per week today. A milestone in tunnel driving was the 3 1/2 mile-long Fucius Tunnel (19 ft wide and 9 ft high) started in A.D. 41 and requiring 30,000 slaves 11 years to complete. The concept of boring machines to drill tunnels goes back to 1882, but the greatest advance has been made in the last five years. A table lists the major completed mole tunneling projects. Cost savings up to 40% over conventional drill-shoot-muck cycle methods can be proven. The requirement for and types of tunnel supports being used are analyzed. A laser beam is an excellent control method for precision drilling with a boring machine. Tunneling safety has progressed to a satisfactory level. During a million man-hours at Blanco Tunnel, Colorado, only six minor lost-time accidents occurred.

226
HOW DILLINGHAM RECONSTRUCTED MAJOR VICTORIA TRUNK SEWER SYSTEM,

G. Beardsley
Eng Contract Record, Vol 84, No 2, pp 40-41, Feb 1971.

Descriptors: *Sewers, *Tunnels, *Pumping plants, *Tunnel construction, Tunneling, Costs.
Identifiers: *Reconstruction, *Canada.

Reconstruction of Greater Victoria's Northwest trunk sewer system, a $2,148,000 contract awarded to the Dillingham Corporation, is approaching completion. Work of constructing the expanded facility combines two different types of tunnel work: open cut and reusing the existing tunnel, and building the necessary pumping and monitoring stations. A new tunnel was needed for 220 feet in areas too deep for open cut and where the original tunnel was through clay and had subsided. This section of the tunnel is a 72-inch diameter steel primary liner plate with a poured concrete invert and a secondary lining of shotcrete. Hand mucking and installation of 18-inch steel liner plate sections was the method used for tunnel advance. The upper end of the trunk system is a 550-foot inverted siphon consisting of twin 24-inch diameter PVC pipe while at the downstream end of the trunk a main pumping station has been built to force the flow through the extended outfall. Construction of the pump station required the excavation of 2300 cubic yards of rock and it contains equipment for comminuting the sewage, measuring the flow, and logging data obtained from other pump stations and metering points in the system.

227
BOSTON STILL FACES A POLLUTION CONTROL PROBLEM; Deep Tunnel Plan Proposed as Solution,

Joseph Cazzaza
Water Wastes Eng, Vol 7, No 9, pp 44-47, Sep 1970.

Descriptors: *Water pollution control, *Pollution abatement, Sewers, Sewerage, Treatment facilities.
Identifiers: *Deep tunnel plan, *Boston, Massachusetts.

In this article the related development of combined sewerage systems in the Boston metropolitan area is traced and some of the major attempts to abate pollution in the harbor and its estuaries are discussed. Presently, the sewage from the area south of the old Boston Main Drainage District is treated at the Nut Island plant, while most of the sewage from the remaining Metropolitan Sewerage District is treated at the Deer Island plant. The two plants provide primary treatment and chlorination for all dry-weather flows from the metropolitan area, yet they cannot handle the enormous quantities of mixed flows during storm conditions. A description of the deep tunnel plan, with an estimated construction cost of $430 million, is included.

228
SOFT-GROUND TUNNELING FOR STORM SEWER,

Henry R. Cooke
Civil Eng, Vol 41, No 4, pp 61-65, Apr 1971. 5 fig, 2 ref.

Descriptors: *Storm drains, *Tunnel construction, *Tunnel design, *Tunnel linings.
Identifiers: *Toronto.

The City of Toronto recently constructed a separate storm sewer to handle runoff from an expressway. They used two tunnel sections, one of 12.5 ft diameter, 8,800 ft long, and one consisting of three parallel 9.5 ft diameter conduits 1,300 ft long. The three parallel conduits were driven under a side hill composed of part fill and part natural ground. Mining of one of the outside conduits caused the lining of the center conduit to crack; it is concluded that the rigid secondary concrete lining should not have been installed in the center conduit until the other conduits were mined. It might have been preferable to have mined the outer conduits first. The tunnel system features several types of primary lining--light 10 gage liner plate with removable steel ribs, steel ribs with concrete planks, and knuckle-jointed unreinforced precast concrete segments. A mole was used for mining some sections of the tunnels, but was abandoned because it caused uncontrollable cracking of the concrete lining, did not operate well in loose granular soil, and was difficult to steer. The following recommendations were derived from this project: (1) use a light-gage liner for the primary lining; and (2) broaden the usefulness of the moles by lessening their dependence on the lining receiving jack thrusts and by providing them with protective hoods for granular soil work.

229
DESIGN OF TUNNEL SUPPORT SYSTEM,

U. D. Deere, R. B. Pack, and J. Monsees
Paper presented at the 49th Annual Meeting of the Highway Research Board, Jan 1970. 18 p, 1 fig, 4 tab, 10 ref.

Descriptors: *Tunnel design, *Supports, Tunnels, Excavation, Gunite, Economics, Tunnel linings, Rock bolts, Tunneling, Tunnel construction.
Identifiers: *Tunnel supports, Rock breakage.

Selection and design of the support system are two of many interrelated factors in the overall design of a serviceable and economical tunnel. The type of support, method of excavation, and character of the ground are inseparable considerations. Factors pertinent to good design of tunnel supports are: 1) types and functions of tunnel support systems; 2) types of primary support systems; 3) planning and design of tunnel support systems; 4) modern concepts of the design of tunnel support systems; 5) guidelines for selecting primary support systems for rock and soil tunnels; and, 6) improvement in support systems for high-speed tunneling. Results of studies conducted at the University of Illinois on various aspects of design of support systems for tunnels are described.

230
DESIGNING THE LININGS OF PRESSURE TUNNELS IN ANISOTROPIC ROCK,
Bureau of Reclamation, Denver, Colorado

V. S. Eristov
Bureau Rec Translation No 740, Mar 1970. 11 p, 3 fig, 4 ref.
Translated from: Gidrotekhn Stroit, No 3, pp 28-31, 1965.

Descriptors: *Underground structures, *Rocks, *Pressure tunnels, *Tunnel linings, *Tunneling, Elasticity (mechanical), Anisotropy,

Formulas are derived for the stresses and radial deformation of a pressure tunnel lining in anisotropic rock using the theory of elasticity. The surrounding rock is assumed to be transformed into a monolithic elastic medium by grouting. It is shown that it is possible to consider, with small error, only radial components of deformation and elastic resistance. By using a constant coefficient of elastic resistance, the formulas are transformed into the formulas for an isotropic medium. The deformations obtained by these formulas for a thin lining coincide reasonably close with the corresponding deformations for an opening in an orthotropic medium loaded along the contour with a uniform radial load. An example calculation is given.

231
HARD ROCK TUNNELING,

T. E. Howard
In: Advisory Conference on Tunneling of the Organization for Economic Co-Operation and Development, Aug 1970. 74 p.

Descriptors: *Tunneling, *Construction, *Underground structures, Drilling.
Identifiers: *Hard rock tunneling, Technological improvement, Questionnaire.

The report is intended to facilitate the orderly development of tunneling technology by focusing attention on the inadequacies of rock tunneling and the improvements that are needed. The data presented were derived from the results of a comprehensive questionnaire that was completed by individuals and organizations in 17 countries.

232
TUNNEL BORING TECHNOLOGY, DISK CUTTER EXPERIMENTS IN SEDIMENTARY AND METAMORPHIC ROCKS,
Bureau of Mines

Roger J. Morrell, William E. Bruce, and David A. Larson
Report of Investigation No 7410, Jul 1970. 32 p, 12 fig, 6 tab.

Descriptors: *Tunnels, *Boring, *Rocks, Excavation.
Identifiers: *Subsurface structures.

Disk-cutter experiments were performed on five rock types ranging in compressive strength from 9,000 psi to 27,000 psi. A specially constructed testing machine called a linear-cutter apparatus (LCA) was designed to load and traverse a free-rolling disk cutter across a sawed rock surface. The LCA was instrumented to measure the vertical and horizontal forces acting on the cutter during the run. The ability of disk cutters to fragment rock was determined for both 60-degree and 90-degree cutting-edge angles, and relationships and regression equations were developed to predict cutter performance based on rock physical properties and applied forces.

233
POTENTIAL IMPACT OF TUNNELS ON WATER POLLUTION AND FLOOD CONTROL IN THE CHICAGO AREA,

Forrest C. Neil
Paper presented at the Am Soc Civil Engrs Environ Meeting, Chicago, Oct 13-17, 1969. 21 p, 6 fig.

Descriptors: *Underground storage, *Tunnels, *Control structures, *Sewers, *Flood control, *Water pollution control, Drainage systems, Design, Storm runoff, Separation techniques.
Identifiers: *Chicago, Illinois.

A novel approach to the solution of water pollution and flood control problems in Chicago is described. It is part of a $2 billion, 10 year approach to meet water quality standards. The present combined sewer systems cannot handle the tremendous quantities of wastewater inputs during periods of precipitation when storm runoff is appreciable. Wastes discharged to the canal system, as a result of the overflows, are contributing to the pollution of Lake Michigan and the surrounding rivers. Sewer separation alone would not improve water quality in the waterways sufficiently to meet established standards. A separate sanitary sewer system would cost over 4 billion dollars. A system of deep tunnels for temporary subsurface storage of combined sewer overflows is desirable. This method could be achieved at less than 25% of the cost of sewer separation, using rock mole machines.

234
IMMERSED TUNNEL CONSTRUCTION,

H. C. Wentink
In: Advisory Conference on Tunneling of the Organization for Economic Co-Operation and Development, Aug 1970. 42 p.

Descriptors: *Tunneling, *Construction, *Underground structures.
Identifiers: *Immersed tunnels, Technological improvement, Questionnaire.

The document is concerned with tunnels composed of elements constructed in a dry-dock or on a slipway and subsequently transported to the construction site, where they are sunk, placed on a foundation, and connected together under water. The questionnaire dealing with immersed tunnels brought in replies from twelve countries, many of which were based only on a theoretical knowledge of the subject or on experience with tunnels of very small cross-section.

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JOURNAL LIST

Abbreviation	Full Title
1. Advan Instr	1. Advances in Instrumentation
2. Am City	2. The American City
3. Appl Microbiol	3. Applied Microbiology
4. Ber Inst Wasserwirt Gesundheitsingenieurwesen	4. Berichte der Institute Wasserwirtschaft Gesundheitsingenieurwesen
5. Beton i Zhelezobeton	5. Beton i Zhelezobeton
6. Brewing Trade Review	6. Brewing Trade Review
7. Chem Eng	7. Chemical Engineering
8. Chem Week	8. Chemical Week
9. Civil Eng	9. Civil Engineering
10. Construct Methods Equip	10. Construction Methods and Equipment
11. Consulting Engr	11. Consulting Engineer
12. Delaware Valley Ind	12. Delaware Valley Industries
13. Effluent Water Treat J	13. Effluent and Water Treatment Journal
14. Eng Contract Record	14. Engineering & Contract Record
15. Eng News-Record	15. Engineering News - Record
16. Filtration Eng	16. Filtration Engineering
17. Gas- Wasserfach (Wasser/Abwasser)	17. Gas- und Wasserfach (Wasser/Abwasser)
18. Gaz, Woda Tech Sanit	18. Gaz, Woda i Technika Sanitarna
19. Heating Ventilation Engr	19. Heating and Ventilation Engineer
20. Inst Civil Engrs (London)	20. Institution of Civil Engineers (London)
21. Instrumentation Technol	21. Instrumentation Technology
22. Iron Age	22. Iron Age
23. J Am Water Works Assoc	23. Journal of the American Water Works Association
24. J Construct Div, Am Soc Civil Engrs	24. Journal of the Construction Division, American Society of Civil Engineers

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25.	J Hydraulics Div, Am Soc Civil Engrs	25.	Journal of the Hydraulics Division, American Society of Civil Engineers
26.	J Hydrol	26.	Journal of Hydrology
27.	J Ind Water Engrs	27.	Journal of the Industrial Water Engineers
28.	J Inst Munic Engrs (London)	28.	Journal of the Institution of Municipal Engineers (London)
29.	J Inst Public Health Engrs	29.	Journal of the Institution of Public Health Engineers
30.	J Irrigation Drainage Div, Am Soc Civil Engrs	30.	Journal of the Irrigation and Drainage Division, American Society of Civil Engineers
31.	J Sanit Eng Div, Am Soc Civil Engrs	31.	Journal of the Sanitary Engineering Division, American Society of Civil Engineers
32.	J Urban Planning Develop Div, Am Soc Civil Engrs	32.	Journal of the Urban Planning and Development Division, American Society of Civil Engineers
33.	J Water Pollution Control Fed	33.	Journal of the Water Pollution Control Federation
34.	Kogai to Taisaku	34.	Kogai to Taisaku
35.	Machine Design	35.	Machine Design
36.	Measurement Control	36.	Measurement and Control
37.	Mod Power Eng	37.	Modern Power Engineering
38.	Nation's Cities	38.	Nation's Cities
39.	Oil Gas J	39.	The Oil and Gas Journal
40.	Petro/Chem Engr	40.	Petro/Chem Engineer
41.	Power	41.	Power
42.	Public Works	42.	Public Works
43.	Sangyo Kogai	43.	Sangyo Kogai
44.	Soc Civil Engrs	44.	The Society of Civil Engineers
45.	Staedtehyg	45.	Staedtehygiene
46.	Surveyor	46.	Surveyor
47.	Toki no Horei	47.	Toki no Horei

48.	Trans, Am Soc Agr Engrs	48.	Transactions, American Society of Agricultural Engineers
49.	Wasser Boden	49.	Wasser und Boden
50.	Wasser Luft Betrieb	50.	Wasser, Luft und Betrieb
51.	Wasserwirtschaft	51.	Die Wasserwirtschaft
52.	Water Pollution Control	52.	Water and Pollution Control
53.	Water Pollution Control (London)	53.	Water Pollution Control (London)
54.	Water Resources Bull	54.	Water Resources Bulletin
55.	Water Resources Res	55.	Water Resources Research
56.	Water Sewage Works	56.	Water & Sewage Works
57.	Water Spectrum	57.	Water Spectrum
58.	Water Wastes Eng	58.	Water and Wastes Engineering
59.	Water Waste Treat J	59.	Water and Waste Treatment Journal

1 *Accession Number*	2 *Subject Field & Group*	**SELECTED WATER RESOURCES ABSTRACTS** INPUT TRANSACTION FORM

5 *Organization*

The Franklin Institute Research Laboratories, 20th Street & The Parkway
Philadelphia, Pennsylvania 19103

6 *Title*

SELECTED URBAN STORM WATER RUNOFF ABSTRACTS (July 1970 - June 1971)

10 *Author(s)*

The Franklin Institute
Research Laboratories

16 *Project Designation*

EPA Project No. 11024 FJE

21 *Note*

22 *Citation*

EPA Contract No 14-12-904, Jul 1971. 173 p.

23 *Descriptors (Starred First)*

Overflow, Sewerage, Sewers, Storm runoff, Drainage systems, Sewage treatment, Storm drains, Treatment facilities, Urbanization, Water pollution control, Water pollution sources.

25 *Identifiers (Starred First)*

*Combined sewers, Great Britain, Storm sewers.

27 *Abstract*

The July 1970 - June 1971 supplement to SELECTED URBAN STORM WATER RUNOFF ABSTRACTS is a compilation of abstracts summarizing articles from a variety of technical literature concerning the problem of urban drainage published from July 1970 through June 1971. The 234 abstracts covering a range of ten sections are arranged alphabetically by author and numerically by abstract number within each category. Each item includes a bibliographic citation, an abstract, and a set of indexing descriptors and identifiers. A subject index at the end of the volume provides the necessary access to individual concepts. An author index and a journal list are also included. The first three quarterly issues fulfilled under Contract 14-12-904 were: SELECTED URBAN STORM WATER RUNOFF ABSTRACTS (First Quarterly Issue): EPA Project No. 11024EJC 10/70; SELECTED URBAN STORM WATER RUNOFF ABSTRACTS (Second Quarterly Issue): EPA Project No. 11024EJC 01/71; and, SELECTED URBAN STORM WATER RUNOFF ABSTRACTS (Third Quarterly Issue): EPA Project No. 11024FJE 04/71. This work was submitted in fulfillment of Contract 14-12-904 (EPA Project No. 11024FJE) between the Environmental Protection Agency, Water Quality Office and the Franklin Institute Research Laboratories.

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11023 --- 05/68	Feasibility of a Stabilization-Retention Basin in Lake Erie at Cleveland, Ohio
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11020 --- 08/70	Combined Sewer Overflow Seminar Papers
11022 DMU 08/70	Combined Sewer Regulation and Management - A Manual of Practice
11023 --- 08/70	Retention Basin Control of Combined Sewer Overflows
11023 FIX 08/70	Conceptual Engineering Report - Kingman Lake Project
11024 EXF 08/70	Combined Sewer Overflow Abatement Alternatives - Washington, D.C.